BRITISH COLUMBIA

Ministry of Transportation and Infrastructure

Commercial Vehicle Inspection Report

FINAL INSPECTION CONFIRMATION NUMBER	PLACE DECAL HERE	DECAL EXPIRY DATE
9513200	EP79097	31 OCT 2014

INSPECTION RESULT: Pass
INSPECTION TYPE: Complete
REASON FOR INSPECTION: Semi-Annual
COLLISION REPAIR FACILITY:

WORK ORDER #	INSPECTION START DATE	INSPECTION COMPLETE DATE
S141687	07 APR 2014 10:40	07 APR 2014 11:06

REASON NOTE:
TECHNICIAN NAME: PHONE #:

INSPECTOR'S NUMBER: M02909
INSPECTOR'S NAME: BAKER, ALAN ROBERT
LICENCE EXPIRY DATE: s.22
FACILITY NUMBER: S0621
FACILITY NAME: PETERBILT PACIFIC INC...
INSPECTION CLASS: 2 - Motor vehicle with lic. GVW of more than 5,500kgs

OWNER/ LESSEE: CITY OF VANCOUVER
ADDRESS: 250 70TH AVENUE W
CITY: Vancouver PROV: BC POSTAL CODE: V5X2X1
REGISTRATION #: VEH. JURISDICTION: NW PLATE:
YEAR: 2014 MAKE: PETERBILT MODEL: 320
BODY STYLE: GRBGE VIN: s.15
ODOMETER: 3150 KM FUEL TYPE: Diesel
UNIT/FLEET #: BRAKE TYPE: Air

"F" Failed "R" Repaired Same Day "P" Passed "PC" Passed With Caution "O" Out Of Service "NA" Not Applicable

	F	R	P	PC	O	NA
Section 1 - Power Train			✓			
Section 2 - Suspension			✓			
Section 3 - Hydraulic Brakes						✓
Section 3A - Air Brakes			✓			
Section 4 - Steering			✓			
Section 5 - Instruments, Auxillary Equipment			✓			
Section 6 - Lamps			✓			
Section 7 - Electrical System			✓			
Section 8 - Body & Frame			✓			
Section 9 - Tires & Wheels			✓			
Section 10 - Couplers & Hitches			✓			
Section 11 - Other Vehicle Components						✓

Pressure Fuel	F	R	P	PC	O	NA
Liquid Propane Gas						✓
Compressed Natural Gas						✓

Pressure Fuel Inspector's Name & Number ,

Air Brake Chamber Type, Size and Push Rod Stroke Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Disc	Disc	Disc						
Size:									
Slack:	Auto	Auto	Auto						
Left:	0	0	0						
Right:	0	0	0						

Comments:

Air Brake Camshaft Rotation Measurement (degrees)

Axle #	1	2	3	4	5	6	7	8	9
Left:	0	0	0						
Right:	0	0	0						

Comments:

Brake Lining/Pad Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Pad	Pad	Pad						
Left:	19	19	19						
Right:	19	19	19						

Comments:

Rotor/Drum Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Rotor	Rotor	Rotor						
Left:	0	0	0						
Right:	0	0	0						

Comments: 1 - DID NOT REMOVE; 2 - DID NOT REMOVE; 3 - DID NOT REMOVE

General Inspection Comments:

Inspector's Name BAKER, ALAN ROBERT Signature _____

The Inspector's signature above is certification that this vehicle has been inspected to the requirements of the Motor Vehicle Act and Regulations.

NOTICE: KEEP THIS VEHICLE INSPECTION REPORT WITH VEHICLE REGISTRATION

The personal information collected on this form is collected under the authority of section 216 of the Motor Vehicle Act and Division 25 of the Motor Vehicle Act Regulations. It is collected for the purpose of processing this vehicle inspection and for generally administering the Vehicle Inspection Program and the National Safety Code (e.g. regulating carriers, authorized inspectors, and designated inspection facilities). If you have any questions about the collection of this information, you may contact the Sr. Manager, NSC/VIP at the Commercial Vehicle Safety Enforcement Branch, by writing to P.O. Box 9250, Stn Prov. Gov't, Victoria, BC V8W 9J2, by e-mailing to vehicle.inspections@gov.bc.ca or calling 250-952-0577.

CVSE0014 (100615)

BRITISH COLUMBIA

Ministry of Transportation and Infrastructure

Commercial Vehicle Inspection Report

FINAL INSPECTION CONFIRMATION NUMBER	PLACE DECAL HERE	DECAL EXPIRY DATE
10925739	EU11753	31 JUL 2016

WORK ORDER #	INSPECTION START DATE	INSPECTION COMPLETE DATE
S152098	28 JAN 2016 16:00	28 JAN 2016 17:30

INSPECTION RESULT: **Pass**
INSPECTION TYPE: **Complete**
REASON FOR INSPECTION: **Semi-Annual**
COLLISION REPAIR FACILITY:

REASON NOTE:
TECHNICIAN NAME: PHONE #:

INSPECTOR'S NUMBER: **102909**
INSPECTOR'S NAME: **BAKER, ALAN ROBERT**
LICENCE EXPIRY DATE: s.22
FACILITY NUMBER: **S0621**
FACILITY NAME: **PETERBILT PACIFIC INC...**
INSPECTION CLASS: **2 - Motor vehicle with lic. GVW of more than 5,500kgs**

OWNER/ LESSEE: **CITY OF VANCOUVER**
ADDRESS: **250 WEST 70TH AVE**
CITY: **Vancouver** PROV: **BC** POSTAL CODE: **V5X2X1**
REGISTRATION #: s.15 VEH. JURISDICTION: **BC** PLATE: **HN0505**
YEAR: **2014** MAKE: **PETERBILT** MODEL:
BODY STYLE: **GRBGE** VIN: s.15
ODOMETER: **7008 KM** FUEL TYPE: **Diesel**
UNIT/FLEET #: **A1531** BRAKE TYPE: **Air**

"F" Failed "R" Repaired Same Day "P" Passed "PC" Passed With Caution "O" Out Of Service "NA" Not Applicable

	F	R	P	PC	O	NA
Section 1 - Power Train			✓			
Section 2 - Suspension			✓			
Section 3 - Hydraulic Brakes						✓
Section 3A - Air Brakes			✓			
Section 4 - Steering			✓			
Section 5 - Instruments, Auxillary Equipment			✓			
Section 6 - Lamps			✓			
Section 7 - Electrical System			✓			
Section 8 - Body & Frame			✓			
Section 9 - Tires & Wheels			✓			
Section 10 - Couplers & Hitches						✓
Section 11 - Other Vehicle Components						✓

Pressure Fuel	F	R	P	PC	O	NA
Liquid Propane Gas						✓
Compressed Natural Gas						✓

Pressure Fuel Inspector's Name & Number ,

Air Brake Chamber Type, Size and Push Rod Stroke Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Disc	Disc	Disc						
Size:									
Slack:	Auto	Auto	Auto						
Left:	0	0	0						
Right:	0	0	0						

Comments:

Air Brake Camshaft Rotation Measurement (degrees)

Axle #	1	2	3	4	5	6	7	8	9
Left:	0	0	0						
Right:	0	0	0						

Comments:

Brake Lining/Pad Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Pad	Pad	Pad						
Left:	19	19	19						
Right:	19	19	19						

Comments:

Rotor/Drum Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Rotor	Rotor	Rotor						
Left:	0	0	0						
Right:	0	0	0						

Comments: 1 - DID NOT REMOVE; 2 - DID NOT REMOVE; 3 - DID NOT REMOVE

General Inspection Comments:

Inspector's Name **BAKER, ALAN ROBERT** Signature _____

The Inspector's signature above is certification that this vehicle has been inspected to the requirements of the Motor Vehicle Act and Regulations.

NOTICE: KEEP THIS VEHICLE INSPECTION REPORT WITH VEHICLE REGISTRATION

BRITISH COLUMBIA

Ministry of Transportation and Infrastructure

Commercial Vehicle Inspection Report

FINAL INSPECTION CONFIRMATION NUMBER	DECAL NUMBER	DECAL EXPIRY DATE
11527224	EW50244	31 MAY 2017

WORK ORDER #	INSPECTION START DATE	INSPECTION COMPLETE DATE
S157214	01 NOV 2016 16:00	01 NOV 2016 17:30

INSPECTION RESULT: Pass
INSPECTION TYPE: Complete
REASON FOR INSPECTION: Semi-Annual
REASON NOTE:
COLLISION REPAIR FACILITY:
TECHNICIAN NAME:
PHONE #:

INSPECTOR'S NUMBER: 102909
INSPECTOR'S NAME: BAKER, ALAN ROBERT
LICENCE EXPIRY DATE: s.22
FACILITY NUMBER: S12620
FACILITY NAME: PETERBILT PACIFIC INC.
INSPECTION CLASS: 2 - Motor vehicle with lic. GVW of more than 5,500kgs

OWNER/ LESSEE: CITY OF VANCOUVER
ADDRESS: 250 WEST 70TH AVE
CITY: Vancouver PROV: BC POSTAL CODE: V5X2X1
REGISTRATION #: s.15 VEH. JURISDICTION: BC PLATE: HN0505
YEAR: 2014 MAKE: PETERBILT MODEL:
BODY STYLE: GRBGE VIN: s.15
ODOMETER: 7008 KM FUEL TYPE: Diesel
UNIT/FLEET #: A1531 BRAKE TYPE: Air

"F" Failed "R" Repaired Same Day "P" Passed "PC" Passed With Caution "O" Out Of Service "NA" Not Applicable

	F	R	P	PC	O	NA
Section 1 - Power Train			✓			
Section 2 - Suspension			✓			
Section 3 - Hydraulic Brakes						✓
Section 3A - Air Brakes			✓			
Section 4 - Steering			✓			
Section 5 - Instruments, Auxillary Equipment			✓			
Section 6 - Lamps			✓			
Section 7 - Electrical System			✓			
Section 8 - Body & Frame			✓			
Section 9 - Tires & Wheels			✓			
Section 10 - Couplers & Hitches						✓
Section 11 - Other Vehicle Components						✓

Pressure Fuel	F	R	P	PC	O	NA
Liquid Propane Gas						✓
Compressed Natural Gas						✓

Pressure Fuel Inspector's Name & Number ,

Air Brake Chamber Type, Size and Push Rod Stroke Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Disc	Disc	Disc						
Size:									
Slack:	Auto	Auto	Auto						
Left:	0	0	0						
Right:	0	0	0						

Comments:

Air Brake Camshaft Rotation Measurement (degrees)

Axle #	1	2	3	4	5	6	7	8	9
Left:	0	0	0						
Right:	0	0	0						

Comments:

Brake Lining/Pad Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Pad	Pad	Pad						
Left:	19	19	19						
Right:	19	19	19						

Comments:

Rotor/Drum Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Rotor	Rotor	Rotor						
Left:	0	0	0						
Right:	0	0	0						

Comments: 1 - DID NOT REMOVE; 2 - DID NOT REMOVE; 3 - DID NOT REMOVE

General Inspection Comments:

Inspector's Name **BAKER, ALAN ROBERT** Signature _____

The Inspector's signature above is certification that this vehicle has been inspected to the requirements of the Motor Vehicle Act and Regulations.

NOTICE: KEEP THIS VEHICLE INSPECTION REPORT WITH VEHICLE REGISTRATION

The personal information collected on this form is collected under the authority of section 216 of the Motor Vehicle Act and Division 25 of the Motor Vehicle Act Regulations. It is collected for the purpose of processing this vehicle inspection and for generally administering the Vehicle Inspection Program and the National Safety Code (e.g. regulating carriers, authorized inspectors, and designated inspection facilities). If you have any questions about the collection of this information, you may contact the Sr. Manager, NSC/VIP at the Commercial Vehicle Safety Enforcement Branch, by writing to P.O. Box 9250, Stn Prov. Gov't, Victoria, BC V8W 9J2, by e-mailing to vehicle.inspections@gov.bc.ca or calling 250-952-0577.

CVSE0014 (100615)

BRITISH COLUMBIA

Ministry of Transportation and Infrastructure

Commercial Vehicle Inspection Report

FINAL INSPECTION CONFIRMATION NUMBER	DECAL NUMBER	DECAL EXPIRY DATE
11610003		

WORK ORDER #	INSPECTION START DATE	INSPECTION COMPLETE DATE
617241	13 DEC 2016 17:00	13 DEC 2016 19:00

INSPECTION RESULT: Fail
INSPECTION TYPE: Complete
REASON FOR INSPECTION: Annual
COLLISION REPAIR FACILITY:

REASON NOTE:
TECHNICIAN NAME: PHONE #:

INSPECTOR'S NUMBER: 113105
INSPECTOR'S NAME: WILSON, DANNIEL WILLIAM
LICENCE EXPIRY DATE: s.22
FACILITY NUMBER: P0240
FACILITY NAME: CITY OF VAN. MANITOBA
INSPECTION CLASS: 2 - Motor vehicle with lic. GVW of more than 5,500kgs

OWNER/ LESSEE: City of Vancouver
ADDRESS: 250 West 70th Ave
CITY: Vancouver PROV: BC POSTAL CODE: V5X 2X1
REGISTRATION #: s.15 VEH. JURISDICTION: BC PLATE: HN0505
YEAR: 2014 MAKE: PETERBILT MODEL:
BODY STYLE: GRBGE VIN: s.15
ODOMETER: 7071 KM FUEL TYPE: Diesel
UNIT/FLEET #: A1531 BRAKE TYPE: Air

"F" Failed "R" Repaired Same Day "P" Passed "PC" Passed With Caution "O" Out Of Service "NA" Not Applicable

	F	R	P	PC	O	NA
Section 1 - Power Train			✓			
Section 2 - Suspension			✓			
Section 3 - Hydraulic Brakes						✓
Section 3A - Air Brakes			✓			
Section 4 - Steering			✓			
Section 5 - Instruments, Auxillary Equipment Replace fire extinguisher		✓				
Section 6 - Lamps			✓			
Section 7 - Electrical System Replace batteries		✓				
Section 8 - Body & Frame			✓			
Section 9 - Tires & Wheels			✓			
Section 10 - Couplers & Hitches						✓
Section 11 - Other Vehicle Components			✓			

Pressure Fuel	F	R	P	PC	O	NA
Liquid Propane Gas						✓
Compressed Natural Gas						✓

Pressure Fuel Inspector's Name & Number ,

Air Brake Chamber Type, Size and Push Rod Stroke Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Disc	Disc	Disc						
Size:									
Slack:									
Left:	00	00	00						
Right:	00	00	00						

Comments: 1 - Auto Adjust Air Disc; 2 - Auto Adjust Air Disc; 3 - Auto Adjust Air Disc

Air Brake Camshaft Rotation Measurement (degrees)

Axle #	1	2	3	4	5	6	7	8	9
Left:	00	00	00						
Right:	00	00	00						

Comments:

Brake Lining/Pad Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Pad	Pad	Pad						
Left:	19	19	19						
Right:	19	19	19						

Comments:

Rotor/Drum Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Rotor	Rotor	Rotor						
Left:	00	00	00						
Right:	00	00	00						

Comments: 1 - Did not remove; 2 - Did not remove; 3 - Did not remove

General Inspection Comments:

Inspector's Name **WILSON, DANNIEL WILLIAM** Signature _____

The Inspector's signature above is certification that this vehicle has been inspected to the requirements of the Motor Vehicle Act and Regulations.

NOTICE: KEEP THIS VEHICLE INSPECTION REPORT WITH VEHICLE REGISTRATION

BRITISH COLUMBIA

Ministry of Transportation and Infrastructure

Commercial Vehicle Inspection Report

FINAL INSPECTION CONFIRMATION NUMBER	DECAL NUMBER	DECAL EXPIRY DATE
11610004	PM07130	31 DEC 2017

WORK ORDER #	INSPECTION START DATE	INSPECTION COMPLETE DATE
617241	13 DEC 2016 17:00	13 DEC 2016 19:00

INSPECTION RESULT: Pass
INSPECTION TYPE: Complete
REASON FOR INSPECTION: Annual
COLLISION REPAIR FACILITY:

REASON NOTE:
TECHNICIAN NAME: PHONE #:

INSPECTOR'S NUMBER: 113105
INSPECTOR'S NAME: WILSON, DANNIEL WILLIAM
LICENCE EXPIRY DATE: s.22
FACILITY NUMBER: P0240
FACILITY NAME: CITY OF VAN. MANITOBA
INSPECTION CLASS: 2 - Motor vehicle with lic. GVW of more than 5,500kgs

OWNER/ LESSEE: City of Vancouver
ADDRESS: 250 West 70th Ave
CITY: Vancouver PROV: BC POSTAL CODE: V5X 2X1
REGISTRATION #: s.15 VEH. JURISDICTION: BC PLATE: HN0505
YEAR: 2014 MAKE: PETERBILT MODEL:
BODY STYLE: GRBGE VIN: s.15
ODOMETER: 7071 KM FUEL TYPE: Diesel
UNIT/FLEET #: A1531 BRAKE TYPE: Air

"F" Failed "R" Repaired Same Day "P" Passed "PC" Passed With Caution "O" Out Of Service "NA" Not Applicable

	F	R	P	PC	O	NA
Section 1 - Power Train			✓			
Section 2 - Suspension			✓			
Section 3 - Hydraulic Brakes						✓
Section 3A - Air Brakes			✓			
Section 4 - Steering			✓			
Section 5 - Instruments, Auxillary Equipment Replace fire extinguisher		✓				
Section 6 - Lamps			✓			
Section 7 - Electrical System Replace batteries		✓				
Section 8 - Body & Frame			✓			
Section 9 - Tires & Wheels			✓			
Section 10 - Couplers & Hitches						✓
Section 11 - Other Vehicle Components			✓			

Pressure Fuel	F	R	P	PC	O	NA
Liquid Propane Gas						✓
Compressed Natural Gas						✓

Pressure Fuel Inspector's Name & Number ,

Air Brake Chamber Type, Size and Push Rod Stroke Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Disc	Disc	Disc						
Size:									
Slack:									
Left:	00	00	00						
Right:	00	00	00						

Comments: 1 - Auto Adjust Air Disc; 2 - Auto Adjust Air Disc; 3 - Auto Adjust Air Disc

Air Brake Camshaft Rotation Measurement (degrees)

Axle #	1	2	3	4	5	6	7	8	9
Left:	00	00	00						
Right:	00	00	00						

Comments:

Brake Lining/Pad Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Pad	Pad	Pad						
Left:	19	19	19						
Right:	19	19	19						

Comments:

Rotor/Drum Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Rotor	Rotor	Rotor						
Left:	00	00	00						
Right:	00	00	00						

Comments: 1 - Did not remove; 2 - Did not remove; 3 - Did not remove

General Inspection Comments:

Inspector's Name **WILSON, DANNIEL WILLIAM** Signature _____

The Inspector's signature above is certification that this vehicle has been inspected to the requirements of the Motor Vehicle Act and Regulations.

NOTICE: KEEP THIS VEHICLE INSPECTION REPORT WITH VEHICLE REGISTRATION

BRITISH COLUMBIA

Ministry of Transportation and Infrastructure

Commercial Vehicle Inspection Report

FINAL INSPECTION CONFIRMATION NUMBER	DECAL NUMBER	DECAL EXPIRY DATE
11972338	PM42637	31 DEC 2017

WORK ORDER #	INSPECTION START DATE	INSPECTION COMPLETE DATE
629863	07 JUN 2017 07:00	07 JUN 2017 12:00

INSPECTION RESULT: Pass
INSPECTION TYPE: Complete
REASON FOR INSPECTION: Semi-Annual
COLLISION REPAIR FACILITY:

REASON NOTE:
TECHNICIAN NAME: PHONE #:

INSPECTOR'S NUMBER: 105825
INSPECTOR'S NAME: Lee, Anthony Edward
LICENCE EXPIRY DATE: s.22
FACILITY NUMBER: P0240
FACILITY NAME: CITY OF VAN. MANITOBA
INSPECTION CLASS: 2 - Motor vehicle with lic. GVW of more than 5,500kgs

OWNER/ LESSEE: City of Vancouver
ADDRESS: 250 70th Ave West
CITY: Vancouver PROV: BC POSTAL CODE: V5X 2X1
REGISTRATION #: s.15 VEH. JURISDICTION: BC PLATE: LB6011
YEAR: 2014 MAKE: PETERBILT MODEL:
BODY STYLE: GRBGE VIN: s.15
ODOMETER: 11388 KM FUEL TYPE: Diesel
UNIT/FLEET #: A1531 BRAKE TYPE: Air

"F" Failed "R" Repaired Same Day "P" Passed "PC" Passed With Caution "O" Out Of Service "NA" Not Applicable

	F	R	P	PC	O	NA
Section 1 - Power Train			✓			
Section 2 - Suspension			✓			
Section 3 - Hydraulic Brakes						✓
Section 3A - Air Brakes			✓			
Section 4 - Steering			✓			
Section 5 - Instruments, Auxillary Equipment			✓			
Section 6 - Lamps			✓			
Section 7 - Electrical System			✓			
Section 8 - Body & Frame			✓			
Section 9 - Tires & Wheels			✓			
Section 10 - Couplers & Hitches						✓
Section 11 - Other Vehicle Components						✓

Pressure Fuel	F	R	P	PC	O	NA
Liquid Propane Gas						✓
Compressed Natural Gas						✓

Pressure Fuel Inspector's Name & Number ,

Air Brake Chamber Type, Size and Push Rod Stroke Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Disc	Disc	Disc						
Size:									
Slack:	Auto	Auto	Auto						
Left:	00	00	00						
Right:	00	00	00						

Comments: 1 - self adjusting disc air; 2 - self adjusting disc air; 3 - self adjusting disc air

Air Brake Camshaft Rotation Measurement (degrees)

Axle #	1	2	3	4	5	6	7	8	9
Left:	00	00	00						
Right:	00	00	00						

Comments:

Brake Lining/Pad Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Pad	Pad	Pad						
Left:	14	14	14						
Right:	14	14	14						

Comments:

Rotor/Drum Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Rotor	Rotor	Rotor						
Left:	44	44	44						
Right:	44	44	44						

Comments:

General Inspection Comments:

Inspector's Name **Lee, Anthony Edward** Signature _____

The Inspector's signature above is certification that this vehicle has been inspected to the requirements of the Motor Vehicle Act and Regulations.

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BRITISH COLUMBIA

Ministry of Transportation and Infrastructure

Commercial Vehicle Inspection Report

FINAL INSPECTION CONFIRMATION NUMBER	PLACE DECAL HERE	DECAL EXPIRY DATE
9602674	EP79082	30 NOV 2014

WORK ORDER #	INSPECTION START DATE	INSPECTION COMPLETE DATE
S142290	14 MAY 2014 13:24	14 MAY 2014 13:45

INSPECTION RESULT: **Pass**
INSPECTION TYPE: **Complete**
REASON FOR INSPECTION: **Semi-Annual**
COLLISION REPAIR FACILITY:

REASON NOTE:
TECHNICIAN NAME: PHONE #:

INSPECTOR'S NUMBER: **M02909**
INSPECTOR'S NAME: **BAKER, ALAN ROBERT**
LICENCE EXPIRY DATE: s.22
FACILITY NUMBER: **S0621**
FACILITY NAME: **PETERBILT PACIFIC INC...**
INSPECTION CLASS: **2 - Motor vehicle with lic. GVW of more than 5,500kgs**

OWNER/ LESSEE: **CITY OF VANCOUVER**
ADDRESS: **250 70TH AVE W**
CITY: **Vancouver** PROV: **BC** POSTAL CODE: **V5X2X1**
REGISTRATION #: VEH. JURISDICTION: **NW** PLATE:
YEAR: **2014** MAKE: **PETERBILT** MODEL: **320**
BODY STYLE: **GRBGE** VIN: s.15
ODOMETER: **3073 KM** FUEL TYPE: **Diesel**
UNIT/FLEET #: BRAKE TYPE: **Air**

"F" Failed "R" Repaired Same Day "P" Passed "PC" Passed With Caution "O" Out Of Service "NA" Not Applicable

	F	R	P	PC	O	NA
Section 1 - Power Train			✓			
Section 2 - Suspension			✓			
Section 3 - Hydraulic Brakes						✓
Section 3A - Air Brakes			✓			
Section 4 - Steering			✓			
Section 5 - Instruments, Auxillary Equipment			✓			
Section 6 - Lamps			✓			
Section 7 - Electrical System			✓			
Section 8 - Body & Frame			✓			
Section 9 - Tires & Wheels			✓			
Section 10 - Couplers & Hitches						✓
Section 11 - Other Vehicle Components						✓

Pressure Fuel	F	R	P	PC	O	NA
Liquid Propane Gas						✓
Compressed Natural Gas						✓

Pressure Fuel Inspector's Name & Number ,

Air Brake Chamber Type, Size and Push Rod Stroke Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Disc	Disc	Disc						
Size:									
Slack:	Auto	Auto	Auto						
Left:	0	0	0						
Right:	0	0	0						

Comments:

Air Brake Camshaft Rotation Measurement (degrees)

Axle #	1	2	3	4	5	6	7	8	9
Left:	0	0	0						
Right:	0	0	0						

Comments:

Brake Lining/Pad Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Pad	Pad	Pad						
Left:	19	19	19						
Right:	19	19	19						

Comments:

Rotor/Drum Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Rotor	Rotor	Rotor						
Left:	0	0	0						
Right:	0	0	0						

Comments: 1 - DID NOT REMOVE; 2 - DID NOT REMOVE; 3 - DID NOT REMOVE

General Inspection Comments:

Inspector's Name **BAKER, ALAN ROBERT** Signature _____

The Inspector's signature above is certification that this vehicle has been inspected to the requirements of the Motor Vehicle Act and Regulations.

NOTICE: KEEP THIS VEHICLE INSPECTION REPORT WITH VEHICLE REGISTRATION

The personal information collected on this form is collected under the authority of section 216 of the Motor Vehicle Act and Division 25 of the Motor Vehicle Act Regulations. It is collected for the purpose of processing this vehicle inspection and for generally administering the Vehicle Inspection Program and the National Safety Code (e.g. regulating carriers, authorized inspectors, and designated inspection facilities). If you have any questions about the collection of this information, you may contact the Sr. Manager, NSC/VIP at the Commercial Vehicle Safety Enforcement Branch, by writing to P.O. Box 9250, Stn Prov. Gov't, Victoria, BC V8W 9J2, by e-mailing to vehicle.inspections@gov.bc.ca or calling 250-952-0577.

CVSE0014 (100615)

BRITISH COLUMBIA

Ministry of Transportation and Infrastructure

Commercial Vehicle Inspection Report

FINAL INSPECTION CONFIRMATION NUMBER	PLACE DECAL HERE	DECAL EXPIRY DATE
9602864	EP79083	30 NOV 2014

INSPECTION RESULT: **Pass**
INSPECTION TYPE: **Complete**
REASON FOR INSPECTION: **Semi-Annual**
COLLISION REPAIR FACILITY:

WORK ORDER #	INSPECTION START DATE	INSPECTION COMPLETE DATE
S142518	14 MAY 2014 14:00	14 MAY 2014 14:26

REASON NOTE:
TECHNICIAN NAME: PHONE #:

INSPECTOR'S NUMBER: M02909
INSPECTOR'S NAME: BAKER, ALAN ROBERT
LICENCE EXPIRY DATE: s.22
FACILITY NUMBER: S0621
FACILITY NAME: PETERBILT PACIFIC INC...
INSPECTION CLASS: 2 - Motor vehicle with lic. GVW of more than 5,500kgs

OWNER/ LESSEE: CITY OF VANCOUVER
ADDRESS: 250 70TH AVE W
CITY: Vancouver PROV: BC POSTAL CODE: V5X2X1
REGISTRATION #: VEH. JURISDICTION: NW PLATE:
YEAR: 2014 MAKE: PETERBILT MODEL: 320
BODY STYLE: GRBGE VIN: s.15
ODOMETER: 5190 KM FUEL TYPE: Diesel
UNIT/FLEET #: BRAKE TYPE: Air

"F" Failed "R" Repaired Same Day "P" Passed "PC" Passed With Caution "O" Out Of Service "NA" Not Applicable

	F	R	P	PC	O	NA
Section 1 - Power Train			✓			
Section 2 - Suspension			✓			
Section 3 - Hydraulic Brakes						✓
Section 3A - Air Brakes			✓			
Section 4 - Steering			✓			
Section 5 - Instruments, Auxillary Equipment			✓			
Section 6 - Lamps			✓			
Section 7 - Electrical System			✓			
Section 8 - Body & Frame			✓			
Section 9 - Tires & Wheels			✓			
Section 10 - Couplers & Hitches						✓
Section 11 - Other Vehicle Components						✓

Pressure Fuel	F	R	P	PC	O	NA
Liquid Propane Gas						✓
Compressed Natural Gas						✓

Pressure Fuel Inspector's Name & Number ,

Air Brake Chamber Type, Size and Push Rod Stroke Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Disc	Disc	Disc						
Size:									
Slack:	Auto	Auto	Auto						
Left:	0	0	0						
Right:	0	0	0						

Comments:

Air Brake Camshaft Rotation Measurement (degrees)

Axle #	1	2	3	4	5	6	7	8	9
Left:	0	0	0						
Right:	0	0	0						

Comments:

Brake Lining/Pad Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Pad	Pad	Pad						
Left:	19	19	19						
Right:	19	19	19						

Comments:

Rotor/Drum Measurement (mm)

Axle #	1	2	3	4	5	6	7	8	9
Type:	Rotor	Rotor	Rotor						
Left:	0	0	0						
Right:	0	0	0						

Comments: 1 - DID NOT REMOVE; 2 - DID NOT REMOVE; 3 - DID NOT REMOVE

General Inspection Comments:

Inspector's Name **BAKER, ALAN ROBERT** Signature _____

The Inspector's signature above is certification that this vehicle has been inspected to the requirements of the Motor Vehicle Act and Regulations.

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CVSE0014 (100615)

BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

Notice And Order Identifier: MV351_20150310_1441_AMD

NOTICE and ORDER

Vehicle(s) inspected this **10** of **MAR** YR **2015** at **14:41** (24hr Clock) on **250 70TH AVE WEST** at or near **Vancouver**

Violation Ticket #:

The undersigned Peace Officer has reasonable and probable grounds to believe that the vehicle(s) inspected and described below does not comply with the Motor Vehicle, Commercial Transport or Passenger Transportation Act and Regulations. The owner/operator is hereby **given notice to:**

PU: ☒ 3. Promptly repair or remedy the defect(s) or omission(s) noted below and present this Notice with the vehicle on or before **PRIOR TO LEAVING** **to 310-1500 Woolridge Street Coquitlam V3K0B8 /FAX:604-527-2214**

This Notice and Order does not authorize operation of the vehicle(s) with identified defects. Non-compliance with this Notice and Order is an offence. Police: ☐ Peace Officer: ☒

Power Unit:

Owner:	**CITY OF VANCOUVER**		
Address:	**250 70TH AVE W**		
City:	**VANCOUVER**	Prov: **BC**	Postal Code: **V5X2X1**
Registration:	s.15	NSC #: **200091810**	Jur: **BC**
Plate #:	**HX1279**	Year: **2014**	Make: **PETERBILT**
Body Style:	**GARBAGE TRUCK**	VIN: s.15	
GVW:	**28123**	Odometer: **999**	**KM**
CVIP decal:		CVIP Jur:	
Cargo Seal #:		UN:	DG Type:

INSPECTION RESULTS "X" - Violation Present "O" - Out of Service "C" - Pass with Caution "N" - Inspection Note

INSPECTION ITEMS	#	PU	COMMENTS
Lighting Devices	41	X	No front left and right side retro reflective devices (amber)
Body & Frame	51	O	Truck unsafe for operation on a highway. Front end lifts off the road surface
	51	N	causing loss of steering control.
Miscellaneous	55	X	Incorrect net weight on registration documents

ADDITIONAL COMMENTS:
Unit A1534 No NSC points to be applied to carrier profile for this inspection.
Truck is Out of Service until repairs have been completed. Contact this inspector once necessary repairs are completed. Unable to verify odometer reading

Peace Officer (Inspector): **G.NEAL** Number: **MV351** Signature: _____

310-1500 Woolridge Street Coquitlam V3K0B8

SEE REVERSE FOR DETAILS REGARDING COMPLIANCE.

The information on this form is collected under the authority of the Motor Vehicle Act, Section 217. The information will be used to process your vehicle inspection and/or Notice and Order. If you have any questions please contact the issuing Officer or call CVSE at (250) 952-0577. Visit www.cvse.ca

MV3073E (072013)

NOTICE AND ORDER COMPLIANCE INFORMATION

You MUST do the following (as indicated on Page 1):

A Notice and Order 3 has been issued to PU: ☒ T1: ☐ T2: ☐ T3: ☐

Immediately correct the defect(s) or omission(s) noted and present this Notice and Order to a Peace Officer at the location indicated, within the time designated, verifying that the required defect(s) or omission(s) have been corrected.

This Notice and Order does not authorize operation of the vehicle(s) with identified defects. Non-compliance with this Notice and Order is an offence.

NOTICE

The owner may choose not to have the vehicle inspected or repaired, but rather to surrender the vehicle license and number plates to the Vice President Operations – ICBC or his/her designate. Should the vehicle license and number plates be surrendered or seized by a Peace Officer, the vehicle owner must make a separate application to ICBC or its agents for a refund.

It is the obligation of the registered owner to advise a subsequent registered owner of any outstanding vehicle inspection requirements.

DISPOSITION

Violation(s) corrected: Yes: ☐ No: ☐ Date: _____ Agency: _____

Peace Officer (Print): _____ Number: _____

WARNING

IT IS AN OFFENCE TO OPERATE A VEHICLE WHICH DOES NOT COMPLY WITH THE MOTOR VEHICLE ACT AND REGULATIONS OR THIS NOTICE AND ORDER. FAILURE TO COMPLY WITH A NOTICE AND ORDER MAY RESULT IN THE REFUSAL OF FURTHER VEHICLE LICENSE TRANSACTIONS. PENALTIES FOR OPERATING A VEHICLE IN CONTRAVENTION OF A NOTICE AND ORDER INCLUDE A FINE AND SEIZURE OF THE VEHICLE LICENSE AND NUMBER PLATES.

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MV3073E (072013)

BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

Notice And Order Identifier: MV351_20150310_1416_AMD

NOTICE and ORDER

Vehicle(s) inspected this **10** of **MAR** YR **2015** at **14:16** (24hr Clock) on **250 70TH AVE WEST** at or near **Vancouver**

Violation Ticket #:

The undersigned Peace Officer has reasonable and probable grounds to believe that the vehicle(s) inspected and described below does not comply with the Motor Vehicle, Commercial Transport or Passenger Transportation Act and Regulations. The owner/operator is hereby **given notice to:**

PU: ☒ 3. Promptly repair or remedy the defect(s) or omission(s) noted below and present this Notice with the vehicle on or before **PRIOR TO LEAVING** to **310-1500 Woolridge Street Coquitlam V3K0B8 /FAX:604-527-2214**

This Notice and Order does not authorize operation of the vehicle(s) with identified defects. Non-compliance with this Notice and Order is an offence. Police: ☐ Peace Officer: ☒

Power Unit:

Owner:	**CITY OF VANCOUVER**		
Address:	**250 70TH AVE W**		
City:	**VANCOUVER**	Prov: **BC**	Postal Code: **V5X2X1**
Registration	s.15	NSC #: **200091810**	Jur: **BC**
Plate #:	**HN0547**	Year: **2014**	Make: **PETERBILT**
Body Style:	**GARBAGE TRUCK**	VIN: s.15	
GVW:	**28123**	Odometer: **4717**	**KM**
CVIP decal:		CVIP Jur:	
Cargo Seal #:		UN:	DG Type:

INSPECTION RESULTS — **"X" - Violation Present "O" - Out of Service "C" - Pass with Caution "N" - Inspection Note**

INSPECTION ITEMS	#	PU	COMMENTS
Lighting Devices	41	X	No front left and right side retro reflective devices (amber)
Body & Frame	51	O	Truck unsafe for operation on a highway. Front end lifts off the road surface
	51	N	causing loss of steering control.
Miscellaneous	55	X	Incorrect net weight on registration documents

ADDITIONAL COMMENTS:
Unit A1533 No NSC points to be applied to carrier profile for this inspection.
Truck is Out of Service until repairs have been completed. Contact this inspector once necessary repairs are completed.

Peace Officer (Inspector): **G.NEAL** Number: **MV351** Signature: _____

310-1500 Woolridge Street Coquitlam V3K0B8

SEE REVERSE FOR DETAILS REGARDING COMPLIANCE.

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MV3073E (072013)

NOTICE AND ORDER COMPLIANCE INFORMATION

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This Notice and Order does not authorize operation of the vehicle(s) with identified defects. Non-compliance with this Notice and Order is an offence.

NOTICE

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It is the obligation of the registered owner to advise a subsequent registered owner of any outstanding vehicle inspection requirements.

DISPOSITION

Violation(s) corrected: Yes ☐ No ☐ Date: _____ Agency: _____

Peace Officer (Print): _____ Number: _____

WARNING

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MV3073E (072013)

BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

Notice And Order Identifier: MV351_20150310_1451

NOTICE and ORDER

Vehicle(s) inspected this **10** of **MAR** YR **2015** at **14:51** (24hr Clock) on **250 70TH AVE WEST** at or near **Vancouver**

Violation Ticket #:

The undersigned Peace Officer has reasonable and probable grounds to believe that the vehicle(s) inspected and described below does not comply with the Motor Vehicle, Commercial Transport or Passenger Transportation Act and Regulations. The owner/operator is hereby **given notice to:**

PU: ☒ 3. Promptly repair or remedy the defect(s) or omission(s) noted below and present this Notice with the vehicle on or before **PRIOR TO LEAVING** to 310-1500 Woolridge Street Coquitlam V3K0B8 /FAX:604-527-2214

This Notice and Order does not authorize operation of the vehicle(s) with identified defects. Non-compliance with this Notice and Order is an offence. Police: ☐ Peace Officer: ☒

Power Unit:

Owner:	**CITY OF VANCOUVER**		
Address:	**250 70TH AVE W**		
City:	**VANCOUVER**	Prov: **BC**	Postal Code: **V5X2X1**
Registration:	s.15	NSC #: **200091810**	Jur: **BC**
Plate #:	**HN0505**	Year: **2014**	Make: **PETERBILT**
Body Style:	**GARBAGE TRUCK**	VIN: s.15	
GVW:	**0028123**	Odometer: **999**	**KM**
CVIP decal:	**PK11185**	CVIP Jur: **BC**	
Cargo Seal #:		UN:	DG Type:

INSPECTION RESULTS — **"X" - Violation Present "O" - Out of Service "C" - Pass with Caution "N" - Inspection Note**

INSPECTION ITEMS	#	PU	COMMENTS
Lighting Devices	41	X	No front left and right side retro reflective devices (amber)
Body & Frame	51	O	Truck unsafe for operation on a highway. Front end lifts off the road surface
	51	N	causing loss of steering control.
Miscellaneous	55	X	Incorrect net weight on registration documents

ADDITIONAL COMMENTS:
Unit A1531 No NSC points to be applied to carrier profile for this inspection.
Truck is Out of Service until repairs have been completed. Contact this inspector once necessary repairs are completed. Unable to verify actual odometer reading.

Peace Officer (Inspector): **G.NEAL** Number: **MV351** Signature: _____

310-1500 Woolridge Street Coquitlam V3K0B8

SEE REVERSE FOR DETAILS REGARDING COMPLIANCE.

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MV3073E (072013)

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It is the obligation of the registered owner to advise a subsequent registered owner of any outstanding vehicle inspection requirements.

DISPOSITION

Violation(s) corrected: Yes ☐ No ☐ Date: _____ Agency: _____

Peace Officer (Print): _____ Number: _____

WARNING

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MV3073E (072013)

R W Baerg
Vehicle Research Inc.

P.O. Box 320
Agassiz, British Columbia
Canada
V0M 1A0
phone: 604-796-8766
email: rbaerg@ivt-eng.com

Low Speed Turning Performance Analysis:

Peterbilt 320 Refuse Truck

Prepared for: **Fort Fabrication and Welding Ltd.**
19439 - 94th Avenue
Surrey, British Columbia
V4N 4E6

Document No: **2015RWB017R1**

Revision: **IR**

Prepared by: **Randolph W. Baerg, PEng**

Date: **February 5, 2106**

Page 16 to/à Page 44

Withheld pursuant to/removed as

Copyright

FPInnovations

2665 East Mall
Vancouver, BC V6T 1Z4

Evaluation of Wayne Engineering Refuse Trucks at the City of Vancouver

Field Testing Observations

for

Commercial Vehicle Safety and Enforcement (BCMOTI)

by

Séamus P.S. Parker R.P.F, P.Eng.

November 10th 2016

Table of Contents

Background

In 2014, steering performance and wheel lift issues resulted in new short wheelbase rear loading refuse trucks operating in the City of Vancouver to be withdrawn from service due to safety concerns. In June 2016, FPInnovations was engaged by Peterbilt Pacific Inc to evaluate the overall truck performance and recommend appropriate measure to address the truck's identified performance issues.

In September 2016, FPinnovations drafted a workplan with input from Peterbilt, the City of Vancouver and the Commercial Vehicle Safety and Enforcement (CVSE) branch of BC Ministry of Transportation and Infrastructure. An engineering analysis (Parker 2016) was conducted which confirmed the deficiencies of the original refuse truck units but showed that modified units with a lighter tailgate, and repositioned packer body (+ 0.1 m forward), and increased wheelbase (+ 0.2 m) would achieve acceptable performance approaching that of existing refuse trucks operating in the city. This analysis recommended that tests be conducted to confirm the reports findings. So on November 8th 2016, tests were conducted at selected locations in Vancouver with the following objectives:

Objectives

- Validate that the modified refuse truck design changes achieve satisfactory performance
- Recommend appropriate operating practices to ensure safe operation of these trucks

Methodology

The modified Wayne Engineering refuse truck was loaded to the following three load conditions:

1. Full load with counterweight (400 kg) on front bumper (Steering axle load 6250 kg; Drive group load 16180 kg)
2. Full load without counterweight (Steering axle load 5700 kg; Drive group load 16000 kg)
3. Partial load (ejector plate rearward) without counterweight (steering axle load 4140 kg; Drive group load 12840 kg)

The tests conducted were all of a qualitative nature based on observations – no instrumentation was used, but video was recorded to assist with the testing. The following tests were conducted based on previous testing conducted by Rona Kinetics (one representative from Rona Kinetics was also present during these tests):

<u>Test 1</u>

Truck starts in stationary position and backs up at 20 to 25 km/h and then applies brakes (Figure 1). Observers noted the level of wheel lift.

Figure 1 Test 1 - reverse and brake

Test 2

Truck starts in stationary position and makes left turn for 90 degree corner (estimated radius 12 m to outside steer tire) at 15 to 20 km/h (Figure 2). The curve had reverse super elevation (outside lean). Observers noted the trucks ability to make corner successfully.

Figure 2. Test 2 - 90 degree turn level ground

Test 3

Truck drives forward over bump in road at speeds ranging between 30 to 50 km/h (Figure 3). Observers noted the trucks steering axle wheel lift and its ability to dampen the axle motion and pitching following the input.

Figure 3. Test 3 – Bump test 30-50 km/h

Test 4a

Truck starts in stationary position and makes left turn for 90 degree corner (estimated radius 11 m to outside steer tire) at 5 to 10 km/h on incline (estimated grade 5%) (Figure 4). Observers noted the trucks ability to make corner successfully.

Figure 4. test 4a – 90 degree turn climbing incline

Test 4b

Truck starts in stationary position and reverses through same incline 90 degrees turn as for Test 4a at 5 to 10 km/h (Figure 5). Observers noted the trucks ability to make corner successfully.

Figure 5. Test 4b – 90 degrees reversing down incline

Test 4c

Truck starts in stationary position and reverses at 5 to 10 km/h down incline and applies brakes (Figure 6). Observers noted the level of wheel lift.

Figure 6. Test 4c – Reverse down incline and brake

Results and Discussion

Full load with counterweight

The steering axle load of 6250 kg is very close to the maximum legal allowance for the tires (315/80R22.5) when loaded with a full load and equipped with a counterweight,; extra care was taken during loading not to exceed the maximum combined steering tire allowance of 6350 kg. This could be an issue in practice so the counterweight load may need to be reduced. The steering axle load as a proportion of drive group was 38.6%, well above the recommended level prescribed in the engineering analysis (33%). Overall the truck performed very well in this condition, with good steering performance under all conditions. See Table 1 for summary of test observations. Axle lift was only noted in Test #1, where the truck was reversed at high speed and brakes applied with estimated decelerations of 0.5 g. This is not a normal safe manoeuvre and little if any wheel-lift occurred under lower speed decelerations. A reduction in steering axle load occurred during the higher speed bump

test on the road (Test#3), with no wheel lift observed. The induced pitching was minimal and was quickly dampened.

Table 1. Test observations- Full load with counterweight

Test #	Wheel-lift	Steering Performance	Notes
1	Yes	NA	Wheel lift occurs at high speeds and decelerations only
2	No	Good	Achieved good steering up to 25 km/h (too fast for corner – roll potential)
3	No	NA	Some wheel load reduction but pitching dampened immediately
4a	No	Good	
4b	No	Good	
4c	No	NA	Front axle load reduced but no visible wheel lift

Full load without counterweight

The steering axle load was 5700 kg when loaded with a full load and the counterweight removed. The steering axle load as a proportion of drive group was 35.6%, still above the recommended level prescribed in the engineering analysis (33%). In this condition the truck performed similarly as was observed for the previous condition with the counterweight. There was no observable difference in performance, with good steering performance under all conditions. See Table 2 for summary of test observations. Axle lift was only noted in Test #1, where the truck was reversed at high speed and brakes applied with estimated decelerations of 0.5 g. As noted previously this is not a recommended operating practice and little if any wheel-lift occurred under lower speed decelerations. A reduction in steering axle load occurred during the higher speed bump test on the road (Test#3), with no observed wheel lift. Again the induced pitching was minimal and was quickly dampened.

Table 2. Test observations- Full load without counterweight

Test #	Wheel-lift	Steering Performance	Notes
1	Yes	NA	Wheel lift occurs at high speeds and decelerations only
2	No	Good	Achieved good steering up to 15 km/h
3	No	NA	Some wheel load reduction but pitching dampened immediately
4a	No	Good	
4b	No	Good	
4c	No	NA	Front axle load reduced but no visible wheel lift

Partial load without counterweight

The steering axle load was reduced to 4140 kg when loaded with a partial load and the counterweight removed. The drive group load was 12 840 kg with the ejector plate located over the tandem group in a worst case rearward position. The steering axle load as a proportion of drive group was 32.2%, just below recommended level (33%). In this condition the truck had more noticeable wheel-lift or bounce particularly in tests 1 and 4c See Table 3 for summary of test observations. Axle lift was more easily achieved backing up particularly on the incline with moderate brake applications. The ejector plate was moved to the most forward position (estimated transfer of 300 kg to steering axle from drive group) and test 4c was repeated eliminating the wheel lift. This indicates that a counterweight would also eliminate the observed wheel lift in these situations. Despite the lighter than recommended steering axle load, steering performance was satisfactory on level ground, going up the incline and descending down it. As well the amount of wheel bounce was relatively low during Test 3 and the pitching appeared to be more easily damped likely due to the lower weight and reduced overall CG height.

Table 3. Test observations- Partial load without counterweight

Test #	Wheel-lift	Steering Performance	Notes
1	Yes	NA	Wheel lift occurs at moderate speeds
2	No	Good	Achieved good steering up to 15 km/h
3	No	NA	Some wheel load reduction but pitching dampened immediately – pitching much reduced relative to full load
4a	No	Good	Some front axle bounce
4b	No	Good	
4c	Yes	NA	Front axle load lift with moderate decelerations

The only potential issue noted during the testing was the increased level of wheel lift observed backing down an incline with a partial load. However this is not a safety concern as the wheel lift only occurs when applying brakes while reversing and is only momentary and quickly stabilizes. This relatively minor issue could either be addressed through modified operating practices and training to minimize its occurrence (e.g. braking procedures, moving ejector plate remotely from cab to transfer weight). It is the author's opinion that the level of wheel lift or bounce is similar to existing trucks and can be safely mitigated through modified operating practices. Another option would be to ensure an appropriate counterweight (300 kg) is installed on the front bumper.

Based on these series of tests, the modified Wayne Engineering refuse truck performs satisfactorily and validates the previous analysis. It is recommended that these modified units go back into service without the counterweight. The City should review operating practices with their drivers to deal with the potential wheel lift or bounce when reversing down inclines with partial loads. The City should then monitor the truck's performance over the initial one month of operation (without counterweight) and if necessary install an appropriate counterweight that will not overload the steering axle tires.

Conclusions

1. The modified refuse truck exhibited good steering performance through all tests including climbing and reversing down inclines.

2. There was no noticeable difference in steering performance observed with and without a counterweight for a fully loaded truck.

3. The level of wheel bounce noted during the high speed (50 km/h) bump test was minimal with no axle lift occurring for all load conditions. The induced pitching resulting from this test was quickly dampened and did not persist.

4. Some wheel lift did occur for the fully loaded trucks when reversing at high speeds and applying brakes. It is estimated that there will be no wheel lift at typical reversing speeds (< 10 km/h).

5. Wheel lift occurred for the partially loaded truck (Ejector plate in rearward position) when reversing down inclines at moderate decelerations. This issue was eliminated when the ejector plate was moved into a forward position.

6. The wheel lift issue observed when reversing down inclines can be addressed through modified operating practices or the use of a 300 kg counterweight on bumper.

Recommendations

1. Allow the modified truck (i.e. light tailgate; wheelbase 3.91 m; packer body moved forward 0.1 m) to return to service without a counterweight.

2. The City of Vancouver should review their operating practices for reversing down inclines and provide the necessary training to their drivers.

3. The City of Vancouver should monitor the truck's performance over its initial month of operation and if necessary install an appropriate counterweight that will not overload the steering axle.

References

Parker, S.P.S. 2016. Evaluation of Wayne Engineering Refuse Trucks at the City of Vancouver - Proprietary report for Peterbilt Pacific Inc 14 pp FPInnovations Vancouver

CITY OF VANCOUVER

Engineering Services

Safe Operating Procedure - Operating Semi Automated Rear Load Packer

Title:	Operation of Semi Automated Rear Load Packer		
Business Unit:	Engineering Services	**Effective Date:**	February 2011
Branch:	Sanitation Services	**Revision Date:**	November 2016

I. PURPOSE AND SCOPE

This Safe Operating Procedure (SOP) has been developed to ensure the safe Collection of Garbage and Yard Waste when operating a Semi Automated Rear Load Packer. This SOP will serve to eliminate and/or control the hazards likely to be encountered by workers performing the task.

II. TOOLS / EQUIPMENT / MATERIALS REQUIRED

The following tools, equipment and materials are required to perform this SOP:

- Rake & Shovel (ergonomic shovels are available upon request)
- 2 Chalk blocks

III. PERSONAL PROTECTIVE EQUIPMENT REQUIRED

The following personal protective equipment is required to perform this SOP:

- ☐ CSA approved steel-toe boots
- ☐ Safety glasses
- ☐ Gloves (task specific)
- ☐ High visibility vest
- ☐ Hearing protection

IV. PREREQUISITES

A. KNOWLEDGE / SKILLS / ABILITIES

- Employee induction / orientation
  - Sanitation Orientation
  - Blood Borne Pathogen Training
  - Hazardous Material Awareness Training
  - Violence Prevention Training

  - Equal Employment Opportunity Training
  - Traffic Control (Sanitation Specific)
- Knowledge of the City of Vancouver Safe Operating Policies
  - Backing Policy
  - Pre/Post Trip Inspection
  - City Radio Usage
- Knowledge of the City of Vancouver safety policies regarding the safe operation of a motor vehicle
- Employee orientation on the rear load packer
- Collections orientation training

B. TRAINING / CERTIFICATION

- Valid Class 3 license with airbrake endorsement

V. PROCEDURE

Complete each step before proceeding to the next one. If at anytime during the performance of this work, additional risks (not identified by this SOP) present themselves, contact your supervisor for further direction / instructions.

1) Inspect (pre-trip) Rear Load Packer using established Pre and Post trip procedures
2) Make sure that there is set of rakes and shovels on the vehicle for each person on the crew
3) When in operation, bring truck to a complete stop. Survey area for trip hazards
4) When climbing in and out of the vehicle, the three point rule must be followed
5) Survey cart that needs to be collected. Test weight and the size of the load
6) Roll container to rear of truck hook onto tipper or in front of claw, stand clear of tote while tipping.
7) Stand to the side of hopper and out of direct line of packing blade while cycling the hopper.
8) If dumping a bag of yard waste, use proper lifting technique and carry bag to the rear of the packer and lift into hopper.
9) When applicable, return the container to its appropriate location

10) Cycle the hopper when required or before relocating to the next job site

11) When driving the rear load packer from the yard to the collection route, move the packing blade to a full forward position. Once collection commences, the packer blade can be put back to the "operational" position. Upon leaving the route, place the packing blade to a full forward position.

12) When operating the rear load packer on an incline, if the operator encounters a steep grade where loss of traction on the front wheels may be an issue, the operator should stop and move the packing blade forward toward the front of the body before proceeding.

13) When dumping at the VSTS, the swamper must assist the driver while backing into the designated stall

14) After dumping is complete, ensure the hopper is clear of any debris
    - If the hopper is not clear, move the vehicle forward to safely clear pit
    - stop engine and remove ignition key
    - remove debris using the long poles provide by the VSTS

15) Set the parking brake before exiting the vehicle

16) Before leaving the VSTS do a walk around and ensure that rear of truck is closed and that pins have been replaced in locks to prevent back from opening.

VI. OTHER INFORMATION

VII. REFERENCES

I. Regulatory References

- *Workers Compensation Regulation*
- *BC Motor Vehicle Act*
- *BC Motor Vehicle Regulations*
- *Commercial Transport Act Regualtion*
- *ICBC Driving Commercial Vehicles*

II. City of Vancouver References

City of Vancouver Safe Driving Policy

City of Vancouver Pre-trip Inspection Form

III. Manufactures Manual

VIII. EMERGENCY PROCEDURES

In the event of a serious medical emergency, contact 911 and then contact your Superintendent or Sub-Foreman.

For minor injuries, contact or go and see a **First Aid Attendant** at the main Administration Building, VSTS, Garage or National Yards.

In the event of difficulties on the job that may pose a safety hazard, contact the Superintendent for further instructions via radio or cell phone.

Procedure Approval

Branch Manager - Administration	**OH&S Safety Committee, Vice Chair**

Peterbilt 320 Refuse Truck (Study Review)

Prepared by:

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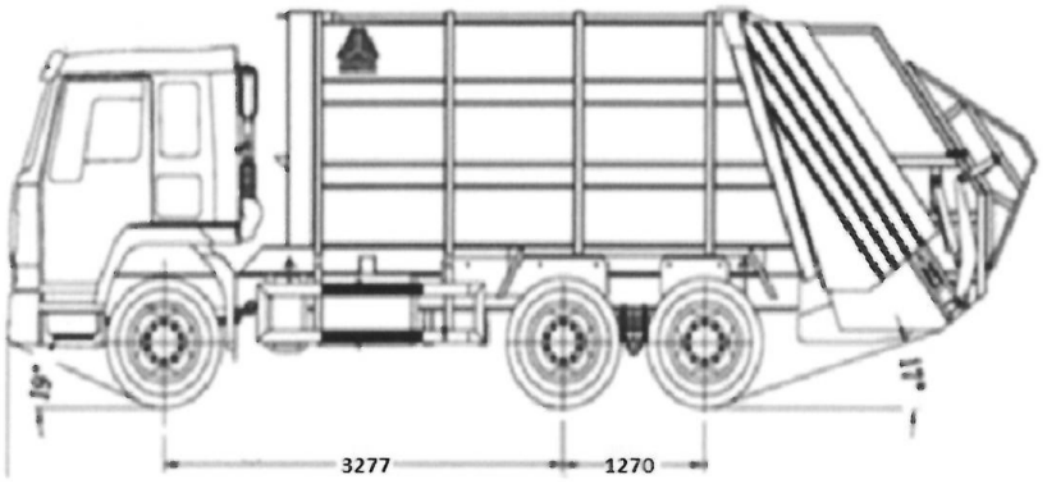
April 20, 2016

1. Vehicle Configuration

Table 1: Examined axle group loads for a similar 3-axle Truck

Full combination weight distribution on each axle group (Kg)				
Data Source	Steering Axle	Second Axle	Third Axle	Total Weight
Vehicle Data (Loaded)_UOIT	7,324	8,013	8,013	**23,350**



2. Analysis

The Low Speed Lateral Friction Utilization (LFU) at 8.05 km/h and 15 km/h and turning radius of 12.8m (measured from the center of the steering axle) is investigated using TruckSim. The investigation is based on the modified version (longer wheelbase) truck given in the report entitled "Low Speed Turning Performance Analysis" dated February 5, 2016.

In this report a similar truck was simulated over various road friction surfaces (road frictions of 0.2, 0.5, 0.8 and 1.0), the results are shown in the tables 2 to 5.

Table 2: In case of road friction 0.2 (Ice or Snow)

Axle Number	Low Speed (LFU) %		Threshold Value %
	Speed (8.05 km/h)	Speed (15 km/h)	
Steering Axle	130.95 (NOT PASS)	174.15 (NOT PASS)	< 80
Tandem drive	241.97 (NOT PASS)	231.74 (NOT PASS)	

Table 3: In case of road friction 0.5 (Wet Asphalt)

Axle Number	Low Speed (LFU) %		Threshold Value %
	Speed (8.05 km/h)	Speed (15 km/h)	
Steering Axle	52.38 (PASS)	73.9 (PASS)	< 80
Tandem drive	96.79 (NOT PASS)	90.87 (NOT PASS)	

Table 4: In case of road friction 0.8 (Dry Asphalt)

Axle Number	Low Speed (LFU) %		Threshold Value %
	Speed (8.05 km/h)	Speed (15 km/h)	
Steering Axle	32.74 (PASS)	46.19 (PASS)	< 80
Tandem drive	60.49 (PASS)	56.59 (PASS)	

Table 5: In case of road friction 1.0 (Dry Concret)

Axle Number	Low Speed (LFU) %		Threshold Value %
	Speed (8.05 km/h)	Speed (15 km/h)	
Steering Axle	26.19 (PASS)	36.95 (PASS)	< 80
Tandem drive	48.39 (PASS)	45.44 (PASS)	

3. Conclusions

The reported test analysis are performed at speed of 15 km/h. The results are close to the simulation results of a similar fully loaded 3-axle truck on road frictions higher than 0.5. The simulation results showed that on road friction equal or less than 0.5, the fully loaded vehicle will suffer from axles lateral saturation (lateral skid or LFU > 0.8) either at the

tandem axles or both the tandem and steering axles on wet asphalt or icy surface at both 15 km/h and 8.05 km/h and turning radius of 12.8m.

The test speed in the report was 15 km/h, which is not the standard test speed for examining the low speed friction utilization (LFU) recommended by either TAC or CVSE. The examination results also showed that satisfying the 0.80 LFU threshold at test conditions of 0.5 coefficient of friction and speed of 15 km/h does not necessarily mean that the LFU threshold is satisfied using the accepted test conditions of 0.2 coefficient of friction and speed of 8.05 km/h.

In conclusion, the conclusions from the test could not determine the exact LFU, but reported that the vehicle could complete the turn without problem. We are not sure about the exact surface friction coefficient. However, this analysis may help understanding the test results. We recommend repeating the tests on low icy surface of 0.2 coefficient of friction at speed close to 8.05 km/h (5 mile/h) because the simulation showed that the variation of the LFU at the steering axle is sensitive to both the test speed and low road friction.

Rear Loader Testing Plan
November 8th Load Testing

Overview

- A1531 will be tested to confirm findings from FPInnovations analysis and report
- Vehicle modifications to be tested include
  - Tailgate that is 670kg lighter than original tailgate
  - Counterweight of approximately 385kg - Truck will be tested both with and without counterweight
  - Wheelbase that has been extended by 0.2m to 3.91m
  - Body that has been moved forward by 0.1m
  - New shock absorbers - Peterbilt to provide details
- Vehicle will be loaded to as close to maximum rear axle loading as possible

Legality and Insurance

- Insurance has expired
- CVSE is indicating that we will have to conduct the test using a repair plate
- CVSE indicates that we cannot drive the truck off site other than on the date of the test

Vehicle Loading - Nov 7th

- Loading will have to take place at the Transfer Station as we are not able to drive the unit off site other than on the day of the test
- Target is to load truck to maximum allowable load of 17,000 kg on rear axle
- Theoretical maximum payload is 8600kg. Suggest loading to 7600kg and checking axle weights, and then loading until we get to 16,800 kg
- Will need front and rear axle weights from Transfer Station scales once truck is loaded
- Sanitation is to look after loading unit on Nov 7th

Testing Scenarios

Drivers

The following drivers will be involved in the testing:

- Randy Wasstrom - Drivers Services, City of Vancouver
- Derek Sever - Equipment Services, City of Vancouver
- Ward Gogol - Sanitation, City of Vancouver

Loading Scenarios

Unit will be tested under two different loading scenarios:

- Loading Scenario 1 - Achieve a steering axle load of at least 5400 kg when loaded to maximum legal drive group weight (17 000 kg) and with one passenger and one driver
- Loading Scenario 2 - With unit emptied of all payload, packing blade in most rearward location and with one passenger and one driver

Counterweight

Truck will also be tested both with and without at 385kg counterweight

FPInnovations

2665 East Mall
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Evaluation of City of Vancouver Refuse Trucks

Work Plan Proposal
for
Peterbilt Pacific Inc.
City of Vancouver
Commercial Vehicle Safety and Enforcement (BCMOTI)

September 2016

Reserved for FPInnovations staff and contract cooperators

CONFIDENTIAL

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Background

Refuse trucks owned by the City of Vancouver were taken out of service due to concerns of poor steering response noted by the Commercial Vehicle Safety and Enforcement (CVSE), a branch of the Ministry of Transportation and Infrastructure. Steering performance tests were subsequently conducted with a modified truck in February 2016 on a low friction surface, which demonstrated good steering performance (Baerg 2016). However, after a review of the test report, the CVSE determined that the test conditions were not satisfactory, as the coefficient of friction was too high to characterize a low friction surface[1]. Following further consultation with CVSE and the City of Vancouver, another performance issue was identified involving steering axle wheel lift on inclines and bumpy roads.

Peterbilt Pacific Inc., the manufacturer of the truck body, approached FPInnovations to review the truck's steering performance and assist them with addressing the noted truck performance issues. On August 31st 2016, FPInnovations met with Peterbilt, the City of Vancouver, and CVSE to discuss the refuse truck's performance issues and determine a plan of action to address these issues; and thereby enable the refuse trucks to resume service. The observations suggest that the truck's performance issues are primarily due to the trucks' rearward load bias with the centre of gravity (CG) just ahead of the drive group centre; which, together with a relatively high CG position, makes the truck susceptible to front wheel lift off at relatively low accelerations. FPInnovations was asked to develop a work plan with the following objectives:

Objectives

- Evaluate the performance issues of the City of Vancouver Refuse trucks
- Recommend appropriate measures needed to address the performance issues

Methodology

FPInnovations will evaluate the 3-axle refuse truck, using appropriate simulation models and performance criteria, to determine the necessary modifications to ensure satisfactory performance. Following these modifications, a field trial will be conducted to observe the modified truck in operation; to ensure that the truck achieves satisfactory performance.

Accordingly, this study will be divided into two phases:

1. Analysis
2. Field test

Details of the second phase field test will be determined following a review of the analysis test report by the City of Vancouver and CVSE.

[1] In order to meet the prescribed test conditions the coefficient of friction should be approximately 0.2 (i.e. ice) based on a National Research Council performance standard for Lateral Friction Utilization (LFU) of the steering axle tires.

Analysis

Simulations will be conducted for the refuse truck for both the original and modified[2] designs for the following 4 loading conditions:

- Empty – compactor in forward position
- Empty – compactor in rearward position
- Loaded at maximum GCW (23 300 kg) – compactor in typical[3] position
- Loaded at maximum GCW – compactor in rearward position

It is understood that the City of Vancouver and Peterbilt will supply FPInnovations with axle loads and compactor body design drawings to enable FPInnovations to accurately estimate loaded and unloaded CG positions required for the analysis. Otherwise FPInnovations will need to take these measurements requiring additional time and cost.

As well, it would also be beneficial to evaluate the performance of existing City of Vancouver Refuse trucks to establish baseline performance which is considered satisfactory by the City of Vancouver. However, this would require additional time and cost.

The following performance measures[4] will be evaluated at each loading condition:

Primary Measures

Static Front wheel Lift Grade (SWL): Determine the grade (%) where the entire load from the front wheels is transferred to the drive axle group when the truck is facing uphill. The provisional performance measure proposed for this evaluation requires that wheel lift not occur at grades below 50%.

Handling performance: Three measures are used to evaluate handling performance at steady-state conditions.
The first measure (Point #1) is the lateral acceleration where the transition from understeer to oversteer (i.e. the point where the understeer coefficient is zero) takes place. The remaining two handling measures are the understeer coefficient at 0.30 g (Point #2) and 0.15 g (Point #3). Understeer coefficient is expressed in degrees per g which represents the slope of the handling diagram. Positive and negative values indicate understeer and oversteer levels respectively. This performance measure is determined during a ramp steer manoeuvre (ramp steer rate of 2 deg/sec at steering wheel) at a forward velocity of 100 km/h. The pass/fail criterion is addressed by comparing the understeer coefficient with the critical understeer coefficient, which can be expressed as -Lg/U2, where U is the vehicle speed (U = 27.77 m/s (100 km/h)), L is the tractor or truck wheelbase (in metres), and g is acceleration due to gravity (9.81 m/s2). If the value of the understeer coefficient is

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[2] Note Peterbilt modified the original design based on the City of Vancouver input- this included lengthening the wheelbase, lightening the tailgate, and moving the body forward.
[3] Typical compactor position will be based on City of Vancouver input and load data
[4] Note the performance measures are divided into primary and secondary measures with the most critical measures affecting the wheel-lift/ steering performance issues considered primary measures. Note SWL and BE are not typically evaluated for configurations in BC.

greater than the critical value, the vehicle will meet the criterion (NRC criterion – Point #2 @ 0.30 g). The criterion for point #1 is to be greater than 0.2 g, while the criterion for point #3 (0.15 g) is for the understeer coefficient to be greater than 0.5 but less than 2 deg/g.

Lateral Friction Utilization (LFU): Lateral friction utilization is a measure proposed by National Research Council of Canada (NRC) to characterize the highest level of the lateral friction utilization at the steering axle. LFU is defined as the ratio of the sum of lateral forces to the vertical load, and the peak tire/road coefficient of adhesion. The tires of a steering axle that achieves a lateral friction utilization level of 1 are said to be saturated. Configuration performance is considered satisfactory if LFU is less than or equal to 0.80 (NRC recommended performance standard). Initially this performance measure was evaluated on a high friction surface ((μ = 0.8). FPInnovations modified this measure by evaluating LFU on low friction surfaces, which are more critical for steering performance, by using low friction tire characteristics (μ = 0.2). This performance measure is evaluated in a 90-degree turn at a vehicle speed of 8.25 km/h. During the manoeuvre, the centre of the front steer axle tracks an arc with a 12.8-m radius (approximately a 14-m outside-wheel-path radius).

Friction Demand (FD): The friction demand performance measure describes the non tractive tire friction levels required at the drive axles of a tractor. Excessive friction demand is a contributing factor to jackknife and also results in excessive tire wear. Friction demand is the absolute value of the ratio of the resultant shear force acting at the drive tires divided by the cosine of the tractor/trailer articulation angle to the vertical load on the drive tires. Configuration performance is considered satisfactory if FD is less than or equal to 0.1 (TAC performance standard). This performance measure is evaluated using the same manoeuvre as used for LFU.

Braking efficiency (BE): Braking efficiency is evaluated for an emergency stop (deceleration 0.4 g's). Braking efficiency is defined as the percentage of available tire/road adhesion limit that can be utilized without incurring wheel lockup. The recommended minimum level of braking efficiency is 70%.

Seconary Measures

Static Rollover Threshold (SRT): This is the level of steady lateral acceleration beyond which the configuration rolls over. The measure is expressed as the lateral acceleration (in g's) at which all wheels on one side, except the steer axle, lift off the ground. Configuration performance is considered satisfactory if the static rollover threshold is greater than or equal to 0.40 g. (TAC). However, internationally a SRT of 0.35 g is considered satisfactory.

Load Transfer Ratio (LTR): The load transfer ratio is defined as the ratio of the absolute value of the difference between the sum of right wheel loads and the sum of the left wheel loads, to the sum of all the wheel loads. The front steering axle is excluded from the calculations because of its relatively high roll compliance. Configuration performance is considered satisfactory if the LTR is less than or equal to 0.60 (TAC performance standard). This performance measure is evaluated during a rapid lane change manoeuvre conducted at 88 km/h, yielding a lateral acceleration amplitude of 0.15 g and a period of 2.5 seconds at the tractor's steering axle.

Rearward Amplification (RWA): Rearward amplification is defined as the ratio of the peak lateral acceleration at the mass centre of the rearmost trailer[5] to that developed at the steering axle of the tractor. Configuration performance is considered satisfactory if the RWA is less than or equal to 1.6 (CVSE bench mark). The current TAC standard is for RWA to be less than 2.0. This performance measure is evaluated in the same manoeuvre as LTR.

Low Speed Offtracking (LSOT): Low speed offtracking is measured as the maximum lateral displacement of the centre-line of the last axle of the configuration from the path taken by the centre of the steer axle. Configuration performance is considered satisfactory if LSOT is less than or equal to 6.0 m (TAC performance standard). This performance measure is evaluated using the same manoeuvre as FD and LFU.

High Speed Steady State Offtracking (HSOT): High speed offtracking is measured as the maximum lateral displacement of the centre-line of the last axle of the configuration from the path taken by the centre of the steer axle. Configuration performance is considered satisfactory if HSOT is less than or equal to 0.46 m (TAC performance standard). This value represents a minimal clearance of 0.15 m between the trailer tires and the outside of a 3.66-m wide conventional traffic lane. This performance measure is evaluated when the vehicle is operated in a 393-m curve radius, at a speed of 100 km/h, thereby attaining a steady lateral acceleration level of 0.2 g.

Transient offtracking (TOT): Transient offtracking is measured as the maximum lateral displacement of the centre-line of the last axle of the configuration from the path taken by the centre of the steer axle. Configuration performance is considered satisfactory if TOT is less than or equal to 0.8 m (TAC performance standard). This performance measure is evaluated in the same manoeuvre as LTR and RWA.

Following the evaluation and discussion of the results, proposed countermeasures (revised truck specifications) will be presented which will enable all performance measures to be met. The same performance measures will be evaluated for a revised truck specification (if considered necessary).

Deliverables:

- Report covering the following:
  - Summary of simulation results
  - Comparison of performance with benchmark values
  - Discussion of results and implications of proposed configuration's safety
  - Proposed countermeasures to address noted truck deficiencies

[5] In this case the mass centre at the truck will be evaluated

Required Information

The following parameters will be required by FPInnovations for the analysis:

- Truck specifications[6] (existing and modified) – Peterbilt
- Axle load distribution for proposed positions – Peterbilt; City of Vancouver
- Truck specifications and load distribution for existing trucks (if necessary) – City of Vancouver

Timeline

The analysis report will be completed by October 11th 2016.

A test plan for the field evaluation will be completed and reviewed by all stakeholders (Peterbilt, CVSE, and City of Vancouver) by October 21st 2016.

Field test to be scheduled for week of October 31st to November 4th 2016.

References

Baerg, R.W. 2016. Low-speed Turning Performance Analysis: Peterbilt 320 Refuse Truck - Proprietary report for Fort Fabrication and Welding Ltd. 30 pp R.W. Baerg Vehicle Research Inc. Agassiz, BC

[6] Specifications include dimensional drawings of truck and compactor body, axle, tire and suspension component information

FPInnovations

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Evaluation of Wayne Engineering Refuse Trucks at the City of Vancouver

Final Report

for

Peterbilt Pacific Inc.

City of Vancouver

Commercial Vehicle Safety and Enforcement (BCMOTI)

by

Séamus P.S. Parker R.P.F, P.Eng.

November 2016

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Background

Refuse trucks owned by the City of Vancouver were taken out of service due to concerns of poor steering response and steering axle wheel lift noted by the Commercial Vehicle Safety and Enforcement (CVSE), a branch of the Ministry of Transportation and Infrastructure. Steering performance tests were subsequently conducted with a modified truck in February 2016 on a low friction surface, which demonstrated good steering performance (Baerg 2016). However, after a review of the test report, the CVSE determined that the test conditions were not satisfactory, as the coefficient of friction was too high to characterize a low friction surface[1]. Following further consultation with CVSE and the City of Vancouver, it was determined that the steering wheel lift performance issue on inclines and bumpy roads had not been specifically addressed during the steering tests.

Peterbilt Pacific Inc., approached FPInnovations to review the truck's steering performance and assist them with addressing the noted truck performance issues. On August 31st 2016, FPInnovations met with Peterbilt, the City of Vancouver, and CVSE to discuss the refuse truck's performance issues and determine a plan of action to address these issues; and thereby enable the refuse trucks to resume service. The observations suggest that the truck's performance issues are primarily due to the trucks' rearward load bias with the centre of gravity (CG) just ahead of the drive group centre; which, together with a relatively high CG position, makes the truck susceptible to front wheel lift off at relatively low accelerations. FPInnovations was asked to develop a work plan to evaluate the issues and determine appropriate solutions to address these issues. Following the approval of the proposed work plan by the stakeholders (City of Vancouver, CVSE, and Peterbilt), FPInnovations initiated the analysis with the following objectives:

Objectives

- Evaluate the performance issues of the City of Vancouver Refuse trucks
- Recommend appropriate measures needed to address the performance issues

Methodology

Analysis of existing vehicles

Simulations were conducted using the University of Michigan Transportation Research Institute (UMTRI) yaw/roll model for the following three refuse truck designs:

- Original Wayne Engineering design as built for City of Vancouver (A1534)

[1] In order to meet the prescribed test conditions the coefficient of friction should be approximately 0.2 (i.e. ice) based on a National Research Council performance standard for Lateral Friction Utilization (LFU) of the steering axle tires.

- Modified[2] design used in low friction tests (A1531) (Figure 1)
- Existing refuse trucks currently used by City of Vancouver (Sterling Condor)(Figure 2)

Figure 1. Modified Wayne Engineering Refuse Truck Design

[2] Note Fort Fabrication modified the original design based on the City of Vancouver input- this included lengthening the wheelbase, lightening the tailgate, moving the body forward, and removing previously installed counterweights on the bumper.

Figure 2. Existing Sterling Refuse Truck Design

For each design the following 5 loading conditions were evaluated:

- Empty – ejector in forward position
- Empty – ejector in rearward position
- Loaded at maximum legal allowance – ejector in typical[3] position
- Loaded at maximum legal allowance – ejector in worst case[4] position
- Partially loaded (3500 kg payload) – ejector in worst case position[5]

These initial simulations were conducted without any counter weights mounted on the front bumper.

The load distribution and mass properties of the three truck designs were estimated from loading data provided by Peterbilt and the City of Vancouver. Payload (garbage) was then placed in the packer cavity at a density of 350 kg/m^3 to achieve the maximum legal drive axle load of 17 000 kg. In all cases the maximum drive group load was reached before the maximum allowable steering axle load (6 300 kg) could be achieved.

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[3] Typical ejector position was based on City of Vancouver input and load data. It is estimated that the ejector plate is typically 0.2 m rearward of its forward position at maximum load capacity.

[4] It was estimated that the ejector plate is 0.5 m rear of its forward position at full load capacity under worst case conditions. It is understood that the packer body manufacturer recommends that the ejector plate be moved to its most forward position when travelling at speeds greater than 10 km/h.

[5] This condition was added following the initial draft report – CVSE request. In this position the ejector plate is estimated to be 2 m rearward from its forward position.

Table 1. Mass distribution of truck designs used in analysis (unloaded)

Design	Wheelbase (m)	Chassis				Packer Body			
		Total Mass (kg)	Sprung Mass (kg)	CGy[a] (m)	CGx[b] (m)	Mass (kg)	CGy[a] (m)	CGx1[c] (m)	CGx[d] (m)
Original	3.71	7270	4595	0.914	0.670	7170	1.864	4.178	4.466
Modified	3.91	7270	4595	0.914	0.670	6500	1.864	4.041	4.342
Existing	4.14	7320	4645	0.914	0.824	7000	1.95	3.75	4.05

a Sprung mass CGy measured from ground. CG = Centre of Gravity.
b Sprung mass CGx measured from steering axle
c CGx – ejector plate forward
d CGx – ejector plate rearward

The following performance measures[6] were evaluated at each loading condition:

Static Front wheel Lift (SWL): Determine the grade (%) where the entire load from the front wheels is transferred to the drive axle group when the truck is facing uphill. The provisional performance measure proposed for this evaluation requires that wheel lift not occur at grades below 50%.

Handling performance: Three measures are used to evaluate handling performance at steady-state conditions.
The first measure (Point #1) is the lateral acceleration where the transition from understeer to oversteer (i.e. the point where the understeer coefficient is zero) takes place. The remaining two handling measures are the understeer coefficient at 0.30 g (Point #2) and 0.15 g (Point #3). Understeer coefficient is expressed in degrees per g which represents the slope of the handling diagram. Positive and negative values indicate understeer and oversteer levels respectively. This performance measure is determined during a ramp steer manoeuvre (ramp steer rate of 2 deg/sec at steering wheel) at a forward velocity of 100 km/h. The pass/fail criterion is addressed by comparing the understeer coefficient with the critical understeer coefficient, which can be expressed as -Lg/U2, where U is the vehicle speed (U = 27.77 m/s (100 km/h)), L is the tractor or truck wheelbase (in metres), and g is acceleration due to gravity (9.81 m/s2). If the value of the understeer coefficient is greater than the critical value, the vehicle will meet the criterion (NRC criterion – Point #2 @ 0.30 g). The criterion for point #1 is to be greater than 0.2 g, while the criterion for point #3 (0.15 g) is for the understeer coefficient to be greater than 0.5 but less than 2 deg/g.

[6] Note the performance measures recommended in this analysis are the most critical measures affecting the wheel-lift/ steering performance. Note SWL and BE are not typically evaluated for configurations in BC.

Lateral Friction Utilization (LFU): Lateral friction utilization is a measure proposed by National Research Council of Canada (NRC) to characterize the highest level of the lateral friction utilization at the steering axle. LFU is defined as the ratio of the sum of lateral forces to the vertical load, and the peak tire/road coefficient of adhesion. The tires of a steering axle that achieves a lateral friction utilization level of 1 are said to be saturated. Configuration performance is considered satisfactory if LFU is less than or equal to 0.80 (NRC recommended performance standard). Initially this performance measure was evaluated on a high friction surface ((μ = 0.8). FPInnovations modified this measure by evaluating LFU on low friction surfaces, which are more critical for steering performance, by using low friction tire characteristics (μ = 0.2). This performance measure is evaluated in a 90-degree turn at a vehicle speed of 8.25 km/h. During the manoeuvre, the centre of the front steer axle tracks an arc with a 12.8-m radius (approximately a 14-m outside-wheel-path radius).

Friction Demand (FD): The friction demand performance measure describes the non tractive tire friction levels required at the drive axles of a tractor. Excessive friction demand is a contributing factor to jackknife and also results in excessive tire wear. Friction demand is the absolute value of the ratio of the resultant shear force acting at the drive tires divided by the cosine of the tractor/trailer articulation angle to the vertical load on the drive tires. Configuration performance is considered satisfactory if FD is less than or equal to 0.1 (TAC performance standard). This performance measure is evaluated using the same manoeuvre as used for LFU.

Braking efficiency (BE): Braking efficiency is evaluated for an emergency stop (deceleration 0.4 g's). Braking efficiency is defined as the percentage of available tire/road adhesion limit that can be utilized without incurring wheel lockup. The recommended minimum level of braking efficiency is 70%.

Low Speed Offtracking (LSOT): Low speed offtracking is measured as the maximum lateral displacement of the centre-line of the last axle of the configuration from the path taken by the centre of the steer axle. Configuration performance is considered satisfactory if LSOT is less than or equal to 6.0 m (TAC performance standard). This performance measure is evaluated using the same manoeuvre as FD and LFU.

Supplementary Simulations were conducted with a Mathworks Simmechanics models to further investigate the dynamics of the front axle wheel lift issue. For this modelling each of the three trucks investigated (original, modified and existing) were subjected to 0.25 g acceleration from 10 km/h to 50 km/h and the steering axle load measured.

Sensitivity analysis

For the worst case condition identified in the simulations, the influence of the following parameters on vehicle performance was investigated:

- Tailgate weight (original and modified)
- Moving packer Body forward (0.1 m)
- Truck wheelbase (+ 0.2 m; + 0.4 m)
- Bumper counter weight (+385 kg; + 770 kg)

Following the sensitivity analysis, proposed countermeasures (revised truck specifications) were investigated with the objective of optimizing the original refuse truck's overall performance.

Results and Discussion

Analysis of existing vehicles

The simulation results of the three existing vehicles are summarized in Table 2 and Table 3 for the empty and loaded modes respectively. The partially loaded condition with 3 500 kg payload is summarized in Table 4.

In the empty mode the only significant performance issues occurred for the original Wayne Engineering design where the static front wheel lift-off (SWL) dipped below the recommended level of 50% when the ejector plate was placed rearward, and lateral friction utilization (LFU) exceeded the recommended level of 80% under all conditions. Both the empty existing City of Vancouver and modified Wayne Engineering trucks exhibited improved SWL and LFU performance meeting the recommended performance targets. However the existing truck exhibited lower than recommended levels of braking efficiency at 67% when the ejector plate is placed in a forward position. All three trucks in the empty mode exhibited higher than recommended levels of understeer at a lateral acceleration of 0.15 g, with understeer coefficients of approximately 4 degrees per g. This higher than recommended level of understeer means that greater steering angles are required to achieve the desired turn- it is a condition that is predictable and can be safely tolerated particularly since similar handling performance occurs with the existing trucks.

In the loaded mode, the original Wayne Engineering truck design exhibited more significant SWL and LFU performance issues. The steering axle tires were completely saturated during the low-speed tight turn maneuver on a low friction surface with a LFU of 1. As well front wheel lift off occurred at a grade of 39.1% when the ejector plate was in its rearward position. Both the modified truck and existing Sterling Condor trucks exhibited acceptable levels of LFU and SWL. In the worst case loading condition, the existing truck does not reach front wheel lift off until a grade of 58.4%, while the modified truck's front wheel lift off occurs at 50.1% (just above the target performance level). Similarly the existing truck's LFU level of 0.737 is better than the modified truck's LFU of 0.795. It would be desirable to enhance the modified truck's performance levels to obtain similar performance exhibited by the existing Sterling Condor trucks.

In the partially loaded condition, all three vehicles had relatively low steering axle loads which resulted in similar steering performance issues noted for the fully loaded vehicles with the ejector plate rearward. However the reduced load resulted in lower CG heights and hence improved levels of SWL. Only the original Wayne Engineering packer body had a SWL below the target level of 50% when partially loaded. Therefore the worst performance characteristics for these vehicles occur at the maximum legal allowance.

Table 2. Simulation results – existing vehicles (empty)

Performance Measures	Performance Standard	Original Truck		Existing Truck		Modified Truck	
		Ejector Plate forward	Ejector Plate rearward	Ejector Plate forward	Ejector Plate rearward	Ejector Plate forward	Ejector Plate rearward
Static Front wheel lift-off	> 50%	60.6	**49.5**	101.3	89.6	85.1	73.1
Handling performance (NRC#1) Transition understeer to oversteer	>0.2 g	0.541	0.534	0.592	0.542	0.678	0.684
Handling performance (NRC#2) USC @ 0.30 g	>-2.70 deg/g	2.786	2.621	3.956	3.751	3.681	3.510
Handling performance (NRC#3) USC @ 0.15 g	> 0.5 deg/g < 2.0 deg/g	**3.944**	**3.970**	**4.281**	**4.128**	**4.147**	**4.039**
Low-speed lateral friction utilization (low friction)	<0.80	**0.850**	**1.000**	0.571	0.634	0.662	0.752
Friction demand	<0.10	0.021	0.022	0.022	0.022	0.018	0.019
Braking Efficiency	> 70%	79.3	84.1	**66.9**	71.5	72.6	77.4
Low-speed offtracking	< 6.00 m	0.536	0.536	0.669	0.669	0.597	0.597
CG Height (m)		1.49	1.49	1.54	1.54	1.47	1.47
CG Horizontal distance from steering axle (m)		2.80	2.97	2.58	2.76	2.66	2.84
Truck wheelbase (m)		3.71	3.71	4.14	4.14	3.91	3.91
Steering axle load (kg)		3 360	2 820	4 880	4 372	4 050	3 550
Drive Group load (kg)		11 050	11 520	9 440	9 948	9 720	10 220
Gross Combination Weight (kg)		14 410	14 340	14 320	14 320	13 770	13 770
Payload (kg)		0	0	0	0	0	0

Bold type indicates performance measure not met

Table 3. Simulation results – existing vehicles (loaded)

Performance Measures	Performance Standard	Original Truck		Existing Truck		Modified Truck	
		Ejector Plate typical	Ejector Plate worst case	Ejector Plate typical	Ejector Plate worst case	Ejector Plate typical	Ejector Plate worst case
Static Front wheel lift-off	> 50%	**41.8**	**39.1**	60.1	58.4	52.5	50.9
Handling performance (NRC#1) Transition understeer to oversteer	>0.2 g	0.304	0.314	0.281	0.285	0.278	0.266
Handling performance (NRC#2) USC @ 0.30 g	>-2.70 deg/g	0.018	0.116	-0.539	-0.435	-0.533	-0.471
Handling performance (NRC#3) USC @ 0.15 g	> 0.5 deg/g < 2.0 deg/g	**2.179**	**2.319**	0.749	1.940	1.694	1.660
Low-speed lateral friction utilization (low friction)	<0.80	**1.000**	**1.000**	0.711	0.737	0.764	0.795
Friction demand	<0.10	0.018	0.018	0.018	0.018	0.015	0.015
Braking Efficiency	> 70%	80.7	82.8	71.8	73.4	72.8	74.5
Low-speed offtracking	< 6.00 m	0.531	0.531	0.662	0.663	0.591	0.591
CG Height (m)		1.73	1.70	1.90	1.87	1.90	1.87
CG Horizontal distance from steering axle (m)		2.99	3.04	3.00	3.05	2.92	2.96
Truck wheelbase (m)		3.71	3.71	4.14	4.14	3.91	3.91
Steering axle load (kg)		4 090	3 740	6 125	5 820	5 570	5 270
Drive Group load (kg)		17 000	17 000	17 000	17 000	17 000	17 000
Gross Combination Weight (kg)		21 090	20 740	23 125	22 820	22 570	22 270
Payload (kg)		6 750	6 400	8 805	8 500	8 800	8 500

Bold type indicates performance measure not met

Table 4. Simulation results – existing vehicles (partially loaded)

Performance Measures	Performance Standard	Original Truck	Existing Truck	Modified Truck
Static Front wheel lift-off	> 50%	**45.5**	77.0	67.5
Handling performance (NRC#1) Transition understeer to oversteer	>0.2 g	0.459	0.491	0.490
Handling performance (NRC#2) USC @ 0.30 g	>-2.70 deg/g	1.526	1.853	1.934
Handling performance (NRC#3) USC @ 0.15 g	> 0.5 deg/g < 2.0 deg/g	**3.168**	**3.664**	**3.746**
Low-speed lateral friction utilization (low friction)	<0.80	**1.000**	0.692	0.760
Friction demand	<0.10	0.021	0.021	0.018
Braking Efficiency	> 70%	84.3	74.6	77.3
Low-speed offtracking	< 6.00 m	0.533	0.668	0.596
CG Height (m)		1.53	1.57	1.52
CG Horizontal distance from steering axle (m)		3.01	2.93	2.89
Truck wheelbase (m)		3.71	3.71	3.71
Steering axle load (kg)		3 347	4 913	4 321
Drive Group load (kg)		14 493	12 907	12 949
Gross Combination Weight (kg)		17 840	17 820	17 270
Payload (kg)		3 500	3 500	3 500

Bold type indicates performance measure not met

Note ejector plate in worst case position in collection mode (< 10 km/h)

Supplementary simulations conducted of the three trucks show that front wheel lift would occur for the original Wayne Engineering design at 0.25 g acceleration when loaded to its worst case loading (Figure 3). This is a fairly extreme acceleration for a truck, but a similar effect could be achieved braking in the reverse direction on a slope at a relatively low deceleration. It is interesting to note that while the modified and existing trucks did not achieve front axle lift-off, the reduction in load was similar to the original truck design. These simulations demonstrate the importance of maintaining a relatively high steering axle weight so that front wheel lift-off will not occur dynamically.

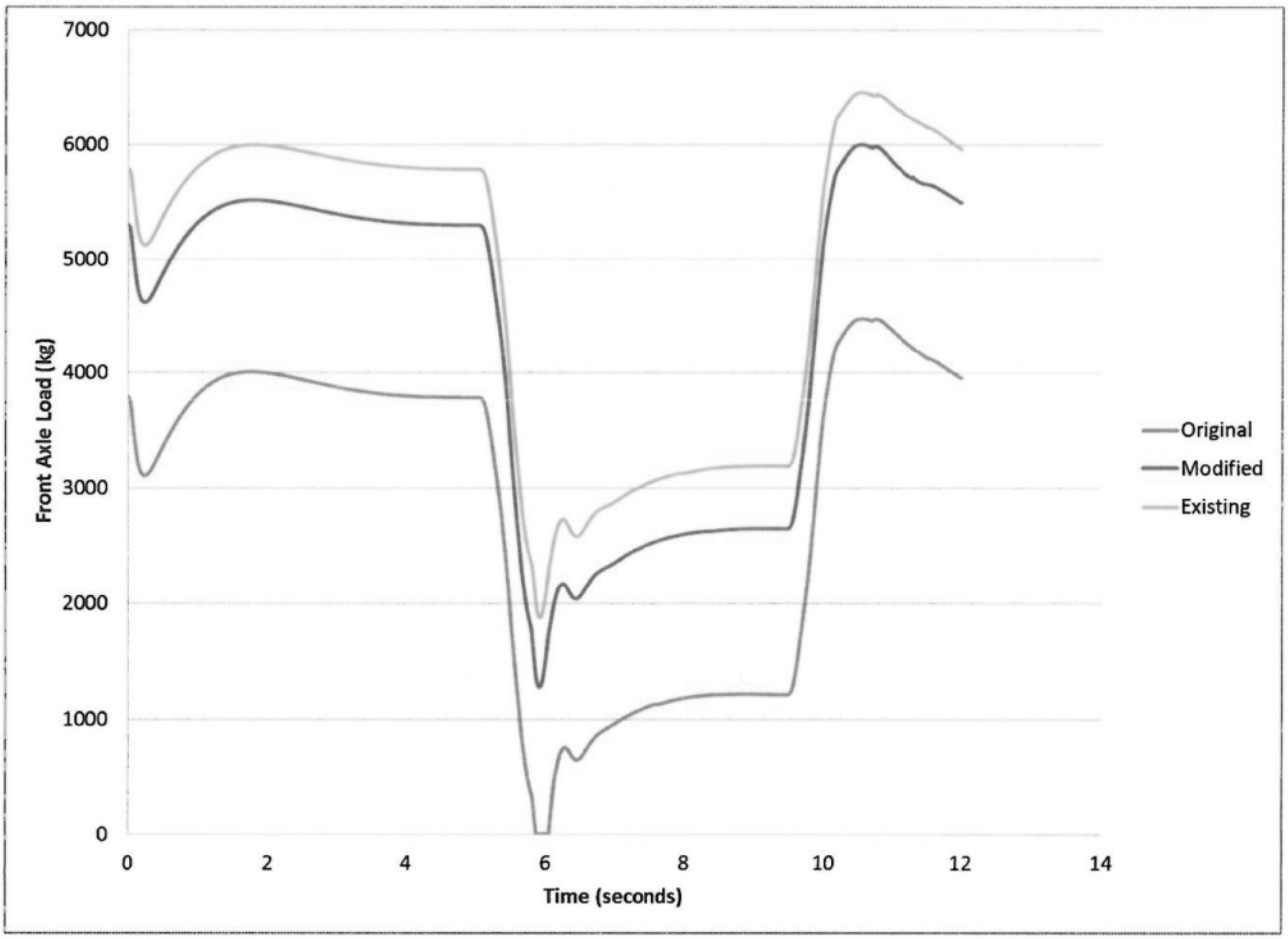


Figure 3. Comparison of steering axle load shift for the three refuse trucks

Sensitivity Analysis

The sensitivity analysis showed that the redesigned lighter tailgate had the greatest influence on improving the performance of the Wayne Engineering refuse truck (Table 5). The addition of a significant bumper counterweight of 770 kg had a greater effect on SWL, but did not improve LFU to the same extent as the lighter tailgate. It is interesting to note that increasing the wheelbase by up to 0.4 m had very little influence on LFU as the steering axle load was only increased marginally. Overall the sensitivity analysis shows that the lighter tailgate is essential but further minor enhancements (moving packer body forward, adding counterweights) are required to achieve acceptable performance for this vehicle. Increasing the wheelbase is of limited benefit. The bottom line is that more weight needs to be transferred to the steering axle by whatever means possible.

Table 5. Effect of parameters on truck performance

Performance Measures	Performance Standard	Original Design	Packer Body 0.1 m forward	Lighter tailgate	Wheelbase + 0.2 m	Wheelbase +0.4 m	Bumper Counterweight + 385 kg	Bumper Counterweight +770 kg
Static Front wheel lift-off	> 50%	**39.1**	**42.6**	**47.1**	**41.7**	**44.3**	**44.5**	**49.3**
Handling performance (NRC#1) Transition understeer to oversteer	>0.2 g	0.314	0.301	0.274	0.306	0.298	0.317	0.323
Handling performance (NRC#2) USC @ 0.30 g	>-2.70 deg/g	0.116	-0.004	-0.563	0.055	-0.037	0.162	0.230
Handling performance (NRC#3) USC @ 0.15 g	> 0.5 deg/g < 2.0 deg/g	**2.319**	**2.175**	1.756	**2.227**	**2.147**	**2.390**	**2.520**
Low-speed lateral friction utilization (low friction)	<0.80	**1.000**	**0.975**	**0.840**	**1.000**	**0.980**	**0.971**	**0.897**
Friction demand	<0.10	0.018	0.018	0.018	0.016	0.014	0.018	0.018
Braking Efficiency	> 70%	82.8	80.1	74.4	83.7	84.4	80.2	78.0
Low-speed offtracking	< 6.00 m	0.531	0.531	0.531	0.592	0.651	0.531	0.532
CG Height (m)		1.70	1.74	1.85	1.70	1.71	1.69	1.68
CG Horizontal distance from steering axle (m)		3.04	2.97	2.83	3.20	3.36	2.96	2.88
Truck wheelbase (m)		3.71	3.71	3.71	3.91	4.11	3.71	3.71
Steering axle load (kg)		3 740	4 190	5 070	3 790	3 840	4 275	4 760
Drive Group load (kg)		17 000	17 000	17 000	17 000	17 000	17 000	17 000
Gross Combination Weight (kg)		20 740	21 190	22 070	20 790	20 840	21 275	21 760
Payload (kg)		6 400	6 850	8 300	6 450	6 550	6 550	6 650

Bold type indicates performance measure not met

Five additional improvement options were evaluated in addition to the modified truck (Table 6). Option 1 (modified truck) essentially meets all the prescribed performance criteria but it would be desirable to improve the performance further to approach that of the existing Sterling Condor truck. Option 2 shows that further enhancements beyond the lighter tailgate and moving the packer body forward 0.1 m are required if the truck wheelbase were to be unchanged from the original design. Option 3 shows that adding 385 kg to the bumper will allow the modified truck to achieve performance approaching that of the existing Sterling Condor truck. Options 4, 5 and 6 show various combinations that could be applied to the original design truck without altering the wheelbase. It should be noted that while options 3 to 6 all exceed the recommended handling performance at 0.15 g, this is not a critical deviation and can be safely tolerated. Essentially acceptable performance for these short wheelbase refuse trucks can be achieved if the minimum steering axle load is at least 5 600 kg at a maximum drive group load of 17 000 kg (i.e. steering axle load 33% of drive group load).

Table 6. Effect of improvement options on truck performance

Performance Measures	Performance Standard	Reference		Improvement options					
		Original Design	Existing (Sterling Condor)	1	2	3	4	5	6
Static Front wheel lift-off	> 50%	**39.1**	58.4	50.9	**48.2**	55.1	52.2	55.7	51.3
Handling performance (NRC#1) Transition understeer to oversteer	>0.2 g	0.314	0.285	0.266	0.271	0.294	0.295	0.303	0.298
Handling performance (NRC#2) USC @ 0.30 g	>-2.70 deg/g	0.116	-0.435	-0.471	-0.410	-0.261	-0.141	0.041	-0.070
Handling performance (NRC#3) USC @ 0.15 g	> 0.5 deg/g < 2.0 deg/g	**2.319**	1.940	1.660	1.721	**2.033**	**2.088**	**2.470**	**2.018**
Low-speed lateral friction utilization (low friction)	<0.80	**1.000**	0.737	0.795	**0.817**	0.748	0.770	0.743	0.791
Friction demand	<0.10	0.018	0.018	0.015	0.018	0.015	0.018	0.018	0.018
Braking Efficiency	> 70%	82.8	73.4	74.5	73.2	72.5	71.2	**69.8**	72.3
Low-speed offtracking	< 6.00 m	0.531	0.663	0.591	0.531	0.591	0.531	0.531	0.531
Improvement options									
Lighter tailgate				Yes	Yes	Yes	Yes	Yes	Yes
Packer Body movement forward (m)				0.10	0.10	0.10	0.10	0.10	0.00
Increase in Truck wheelbase (m)				0.20	0.00	0.20	0.00	0.00	0.00
Addition of counterweight on bumper (kg)				0	0	385	385	770	385
CG Height (m)		1.70	1.87	1.87	1.87	1.86	1.86	1.84	1.84
CG Horizontal distance from steering axle (m)		3.04	3.05	2.96	2.81	2.89	2.74	2.69	2.77
Truck wheelbase (m)		3.71	4.14	3.91	3.71	3.91	3.71	3.71	3.71
Steering axle load (kg)		3 740	5 820	5 270	5 270	5 755	5 755	6 140	5 555
Drive Group load (kg)		17 000	17 000	17 000	17 000	17 000	17 000	17 000	17 000
Gross Combination Weight (kg)		20 740	22 820	22 270	22 270	22 755	22 755	23 140	22 555
Payload (kg)		6 400	8 500	8 500	8 500	8 600	8 600	8 600	8 400

Bold type indicates performance measure not met

Option 1 is modified truck design

In order to validate this analysis it is recommended that a field trial be conducted with the modified truck. The truck should be loaded to the maximum legal load allowance with typical material hauled by these vehicles. The truck should then be driven through an appropriate route recommended by the City of Vancouver to ensure that the truck meets performance requirements. It is recommended that the testing be conducted with and without a counterweight (350-500 kg) mounted to the front bumper. Other means of varying steering axle weights should be investigated.

Conclusions

1. The analysis confirmed that the original Wayne Engineering refuse truck design built for the City of Vancouver exhibits performance issues related to steering performance (lateral friction utilization) and front wheel lift-off. The worst case conditions occur when the vehicles are fully loaded and the ejector plate in its worst case position (0.5 m rear of forward position with a full load).

2. The analysis also showed that the modified version of the Wayne Engineering refuse truck would meet all the prescribed performance measures including lateral friction utilization and static front wheel lift-off. However, the modified refuse truck's performance was slightly reduced relative to existing refuse trucks used by the City of Vancouver (Sterling Condors).

3. All three refuse trucks evaluated in the empty mode exhibited higher than recommended levels of understeer at a lateral acceleration of 0.15 g, with understeer coefficients of approximately 4 degrees per g. This higher than recommended level of understeer means that greater steering angles are required to achieve the desired turn; it is a condition that is predictable and can be safely tolerated, particularly since similar handling performance occurs with the existing trucks.

4. The sensitivity analysis showed that the redesigned lighter tailgate had the greatest influence on improving the performance of the Wayne Engineering refuse truck. Therefore, it is essential that the lighter tailgate be adopted; but further minor enhancements (moving packer body forward, adding counterweights) are also required to achieve acceptable performance for this vehicle. Increasing the wheelbase was shown to be of limited benefit. In order to achieve acceptable performance more weight needs to be transferred to the steering axle by whatever means possible.

5. The modified truck essentially meets all the prescribed performance criteria but it would be desirable to improve the performance further to approach that of the existing Sterling Condor truck. One potential option is the addition of a 385 kg counterweight to the modified truck's bumper which will allow the modified truck to achieve performance approaching that of the existing Sterling Condor truck.

6. Various combinations of other options could also be applied to the original design truck to achieve acceptable performance without altering the wheelbase. Essentially, acceptable performance for these short wheel base refuse trucks can be achieved if the minimum steering axle load is at least 5 600 kg at a maximum drive group load of 17 000 kg (i.e. steering axle load 33% of drive group load).

Recommendations

1. It is recommended that a field trial assessment of the modified Wayne Engineering truck design be conducted, to confirm the findings of this analysis. It is important that the truck be loaded to the maximum legal allowance with typical material.

2. An appropriate test route should be determined through consultation with the City of Vancouver. The route should be able to test the steering performance and wheel lift issues, such as backing up on an incline and turning a corner. Testing should be conducted with and without additional weight (350-500 kg) on the steering axle (e.g. counterweights on bumper).

3. The truck should be adapted so that steering axle weights may be easily adjusted throughout the trial.

References

Baerg, R.W. 2016. Low-speed Turning Performance Analysis: Peterbilt 320 Refuse Truck - Proprietary report for Fort Fabrication and Welding Ltd. 30 pp R.W. Baerg Vehicle Research Inc. Agassiz, BC

Sanitation Rear Loader Re-Introduction Plan
Dec 1, 2016

Purpose
To prove or disprove the suitability of the modified Wayne Rear Loading Refuse trucks under "real world conditions".

Trial Period
The initial trial period will be set for two weeks. At the end of two weeks, Sanitation will determine if an additional two week trial period is required.

Training
A full re-orientation of operators will be provided where we will:

- Review the new SOP
- Review the Pre and Post Trip procedures for this specific unit
- Ensure the operators have a chance to have any of their questions addressed

Only operators that have received re-orientation will be allowed to operate this equipment through the trial period.

Operators
The initial operators that will run the unit are those that have been involved through the testing process. This includes:

- Ward Gogol
- Matt Baillie
- Jim Hammermeister

Once these operators have used the units safely and provided positive feedback, additional operators will be trained and exposed to the units.

Issue Documentation
Any operator using the equipment will be asked to fill in the provided "Operator Feedback Form" on each day that they have used the equipment. The forms will be turned in to Troy De Graaf at the end of the shift and a copy will be provided to Equipment Services.

Routes
The truck will begin operation on a "spare" green or garbage route (spare = a route made up of different spare blocks taken from full or regular routes). This will allow the drivers to operate the vehicle in various lane conditions across a zone so we are able to use the truck in different scenarios for the first few days.

After a successful re-introduction via a "spare" route, we will introduce the truck to a regular garbage or green route.

Acceptance Criteria

Operator Feedback Form

Date:_____

Name of Operator:_____

Type of Refuse Hauled (i.e. Refuse, Green Waste):

General Area of Use (i.e. South Vancouver, Kitsilano, etc.)

Description of Weather and Road Conditions (i.e. Dry, Raining, Freezing)

Description of any issues or challenges faced (i.e. bouncing cab, loss of traction, etc.)

General Comments

SAFETY DECALS

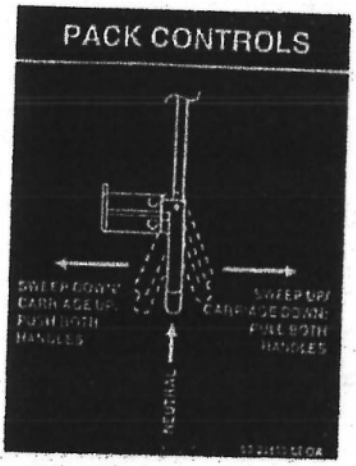
TAILGATE PROP OPERATION

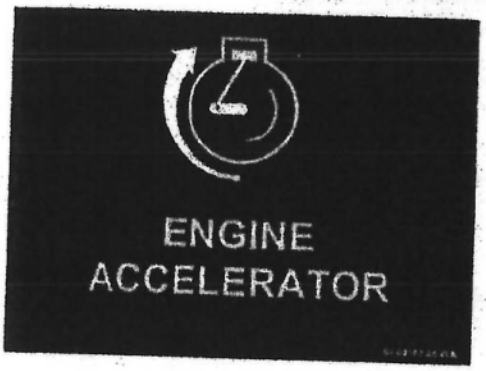
⚠ CAUTION TAILGATE MUST BE UNLOADED BEFORE USING PROPS. BOTH PROPS MUST BE USED TO SUPPORT TAILGATE.

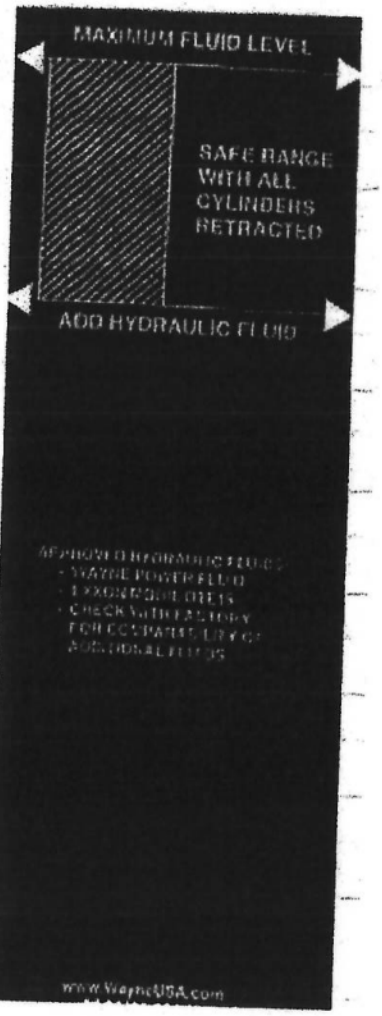
TO USE PROPS:
1) RAISE TAILGATE TO A HEIGHT WHERE PROPS CAN BE MOVED INTO POSITION.
2) ROTATE FORWARD UNTIL PROP IS IN THE DOWN POSITION.
3) LOWER TAILGATE UNTIL TAILGATE PROPS SUPPORT THE WEIGHT OF TAILGATE.
4) VISUALLY INSPECT TO SEE THAT PROPS ARE SECURE.

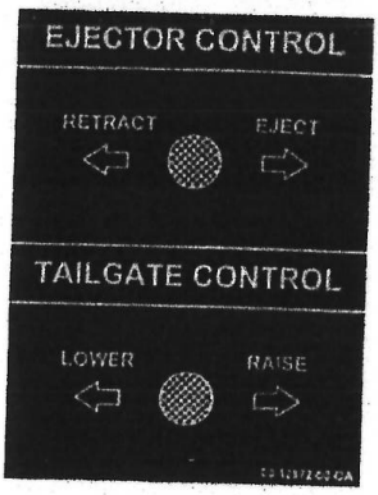
⚠ DANGER DO NOT ENTER INTO THE TAILGATE AREA UNLESS LOCKOUT/TAGOUT PROCEDURES ARE IN EFFECT.

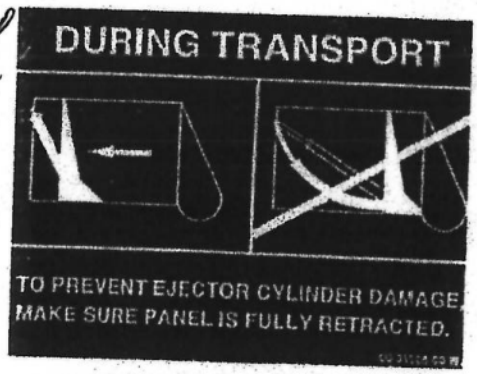
TO STORE PROPS:
1) RAISE TAILGATE SLIGHTLY.
2) ROTATE PROPS UP INTO THE STORED POSITION.
3) LOWER TAILGATE TO CLOSED POSITION.

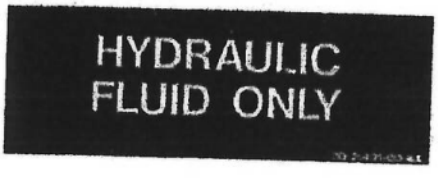


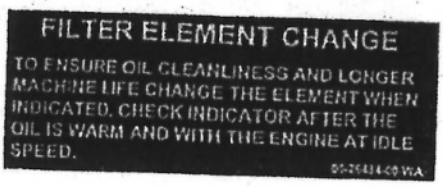












MAIN CONTROL BOX

1) SYSTEM ON SWITCH –This switch enables/ disables the PTO and engine acceleration circuit.

2) SYSTEM ON LIGHT -The system on light is illuminated whenever the system is on.

3) TAILGATE OPEN LIGHT -The tailgate open light is illuminated whenever the tailgate is not closed.

4) STROBE OR BEACON TOGGLE SWITCH -This switch is a standard optional toggle switch allowing a strobe light to be installed.

5) WORK LIGHT TOGGLE SWITCH -This switch is a standard optional toggle switch allowing a work light to be installed.

6) PTO LIGHT -The PTO light is illuminated whenever the PTO is engaged.

UNLOADING CONTROLS (THE 2 SPOOL VALVE IS LOCATED AT THE FORWARD, LEFT HAND SIDE OF THE BODY)

1) TAILGATE CONTROL LEVER

Be certain no one is near the tailgate when the tailgate control levers are activated. The tailgate lift cylinders are controlled by pushing in on the tailgate control lever to lower the tailgate and pulling out to raise the tailgate.

2) EJECTOR PANEL CONTROL LEVER

The ejector panel extends into the body when the ejector control lever is pushed inward and the ejector panel retracts to the front of the body when the ejector control lever is pulled outward from the body. When transporting the vehicle, move the ejector panel forward in the body

3) ENGINE ACCELERATOR SWITCH

The engine accelerator switch is installed on the 2 spool valve bracket adjacent to the tailgate and ejector panel control levers. Actuation of this electric switch will speed up the engine to provide adequate hydraulic pressure and flow for raising the tailgate and ejector panel functions.